Environmental Green Cover and Mental Wellbeing in Malta

Gary Camilleri [redacted]

A dissertation submitted in partial fulfilment of the requirements of the degree of Master of Science in Public Health

Department of Public Health

Faculty of Medicine and Surgery

University of Malta

2025

L-Università ta' Malta

FACULTY/INSTITUTE/CENTRE/SCHOOL Faculty of Medicine & Surgery

Student's I.D. /Code [redacted]

Student's Name & Surname GARY CAMILLERI

Course Master of Science in Public Health

Title of Dissertation/Thesis

Environmental Green Cover and Mental Wellbeing in Malta

I am hereby submitting my dissertation/thesis for examination by the Board of Examiners.

[redacted]

GARY CAMILLERI
Name of Student (in Caps)

04/12/2025
Date

Submission noted.

[redacted]
(in Caps)

[redacted]
Signature

4/12/2025
Date

[redacted]

10.02.2018

L-Università ta' Malta

FACULTY/INSTITUTE/CENTRE/SCHOOL Faculty of Medicine & Surgery

DECLARATIONS BY POSTGRADUATE STUDENTS

(a) Authenticity of Dissertation

I hereby declare that I am the legitimate author of this Dissertation and that it is my original work.

No portion of this work has been submitted in support of an application for another degree or qualification of this or any other university or institution of higher education.

I hold the University of Malta harmless against any third party claims with regard to copyright violation, breach of confidentiality, defamation and any other third party right infringement.

(b) Research Code of Practice and Ethics Review Procedures

I declare that I have abided by the University's Research Ethics Review Procedures. Research Ethics & Data Protection form code MED-2025-00061.

As a Master's student, as per Regulation 77 of the General Regulations for University Postgraduate Awards 2021, I accept that should my dissertation be awarded a Grade A, it will be made publicly available on the University of Malta Institutional Repository.

02.2023

L-Università ta' Malta

FACULTY/INSTITUTE/CENTRE/SCHOOL Faculty of Medicine & Surgery

DECLARATIONS BY POSTGRADUATE STUDENTS

Student's Code 20496G

Student's Name & Surname Gary Camilleri

Course Master of Science in Public Health

Title of Dissertation

Environmental Green Cover and Mental Wellbeing in Malta

(a) Authenticity of Dissertation

I hereby declare that I am the legitimate author of this Dissertation and that it is my original work.

No portion of this work has been submitted in support of an application for another degree or qualification of this or any other university or institution of higher education.

I hold the University of Malta harmless against any third party claims with regard to copyright violation, breach of confidentiality, defamation and any other third party right infringement.

(b) Research Code of Practice and Ethics Review Procedures

I declare that I have abided by the University's Research Ethics Review Procedures. Research Ethics & Data Protection form code MED-2025-00061.

As a Master's student, as per Regulation 77 of the General Regulations for University Postgraduate Awards 2021, I accept that should my dissertation be awarded a Grade A, it will be made publicly available on the University of Malta Institutional Repository.

[redacted]

GARY CAMILLERI
Name of Student (in Caps)

04/12/2025
Date

02.2022

Acknowledgements

I would like to express my sincere gratitude to my family, whose unwavering support, encouragement, and patience have sustained me throughout this journey. Their belief in my abilities has been a constant source of strength.

I am deeply grateful to my supervisor, Dr Roberto Debono, for his continuous guidance, insightful feedback, and steadfast mentorship. His dedication and expertise were invaluable at every stage of this work. I also extend my appreciation to Prof. Neville Calleja for his professional advice, particularly in the statistical aspects of this dissertation, which greatly enhanced the rigour and clarity of the analysis.

Finally, I would like to thank all those who, in various ways, contributed to the development and completion of this study. Their support has been truly appreciated.

Summary

This study investigates the relationship between environmental green cover and mental wellbeing among adults living in Malta, offering one of the first national assessments that integrates geospatial greenery measures with validated psychological wellbeing tools. Green spaces are internationally recognised for their capacity to reduce stress, enhance mood, strengthen social ties, and promote physical activity. Yet, in small island states such as Malta—where land is limited, urban density is high, and green infrastructure is unevenly distributed—the extent to which environmental greenery contributes to mental wellbeing has remained unclear. This study addresses this gap by exploring whether objective measures of greenery surrounding participants' homes and workplaces are associated with mental wellbeing, while considering key behavioural, environmental, and socio-demographic influences.

A cross-sectional sample of 691 adults was recruited across educational institutions, workplaces, and primary care settings. Mental wellbeing was measured using the WHO-5 index, while environmental green cover (grassland, tree canopy, cropland, and total greenery) was quantified within 300 m and 900 m buffers using high-resolution land-cover datasets. After geocoding residential and workplace street names, a comprehensive analysis was undertaken, including descriptive statistics, correlation testing, and multivariable regressions adjusting for demographics, physical activity, chronic disease, social cohesion, sedentary behaviour, and residential conditions.

Findings showed considerable variability in both mental wellbeing scores and environmental greenery across Malta and Gozo. Bivariate correlations between greenery and mental wellbeing were weak and non-significant at both buffer distances, and regression models confirmed that environmental greenery did not independently predict mental wellbeing once confounders were included. Instead, stronger predictors emerged, particularly

social cohesion, physical activity, housing quality, sedentary behaviour, and chronic illness. These results align with international literature suggesting that the benefits of greenery are mediated through behavioural and social pathways, and that simple measures of quantity may overlook the importance of quality, safety, accessibility, and actual use.

The study carries several implications for public health and urban planning in Malta. First, increasing the amount of greenery alone is unlikely to yield significant improvements in population mental wellbeing. Instead, efforts should prioritise enhancing the quality, usability, and accessibility of green spaces, ensuring they are well-maintained, safe, shaded, and equipped with facilities that encourage both social interaction and physical activity. Second, interventions should address inequities in access to high-quality green environments, as disadvantaged communities often face greater environmental burdens and may benefit most from targeted greening initiatives. Third, integrating health considerations into environmental and urban development policies can support more holistic approaches to wellbeing, especially by linking green infrastructure planning with strategies for heat mitigation, active travel, and chronic disease prevention.

Recommendations for future research include adopting longitudinal designs to better establish causality; incorporating subjective assessments of perceived greenery, quality, and safety; evaluating patterns of actual use of green spaces; and examining the influence of micro-scale greenery such as street trees and pocket parks. Expanding research to include cultural and behavioural factors specific to small island states would further strengthen policy relevance.

Overall, this study contributes foundational evidence on environmental greenery and mental wellbeing in Malta. While objective greenery alone does not independently predict wellbeing, the findings highlight the importance of social, behavioural, and environmental

conditions that shape how residents interact with and benefit from nearby green spaces. These insights underscore the value of context-sensitive, equity-driven, and health-informed urban greening strategies for supporting population mental wellbeing.

Contents

List of Figures

List of Tables

Introduction

1.1 Background of the Study

In recent decades, there has been growing recognition of the intricate connections between the environment and human wellbeing. One of the most compelling areas of research concerns the relationship between exposure to environmental greenery and mental wellbeing, which has gained traction across public health, urban planning, and psychological disciplines. This surge of interest is driven not only by rising rates of mental distress but also by increasing urbanisation and dwindling contact with nature in everyday life.

More than half the global population currently lives in urban areas. This is a figure projected to reach nearly 70% by 2050. While urban areas drive economic growth and innovation, they are often linked to factors such as air and noise pollution, overcrowding, and social fragmentation, all of which can be a detriment to mental wellbeing (Gong et al., 2016). Simultaneously, mental health challenges have reached unprecedented levels. The World Health Organization (WHO) estimates that 1 in 8 people globally live with a mental disorder, with depression and anxiety ranking among the top contributors to years lived with disability.

Amidst these challenges, green spaces have been shown to be an accessible, community-level resource for promoting mental wellbeing. Green spaces are not just visually appealing amenities but are increasingly viewed as essential determinants of individual and public health. Defined broadly as vegetated areas such as parks, woodlands, gardens, and green corridors, green spaces can buffer psychological stress, foster social connectedness, encourage physical activity, and enhance cognitive functioning (Hartig et al., 2014; Twohig-Bennett & Jones, 2018). Despite these benefits, access to high-quality green space is often unequal, especially in low-income or high-density urban communities (Wolch, Byrne & Newell, 2014).

In this context, understanding the intersection between green space and mental wellbeing, not merely the absence of illness, presents both a challenge and an opportunity. It allows for the development of proactive urban design and public health interventions that foster thriving populations rather than simply treating disorders.

1.2 Key Concepts

1.2.1 Environmental Greenery

Environmental greenery is generally defined as outdoor areas dominated by vegetation that are accessible for recreation, relaxation, or visual enjoyment (European Environment Agency, 2019). These may include public parks, community gardens, cemeteries, street trees, allotments, and peri-urban woodlands. Some scholars also include “blue spaces” (e.g., rivers, lakes, coastal areas) within this definition due to their similar psychological and restorative effects (Gascon et al., 2017). Importantly, green space is not a homogenous concept; the size, quality, accessibility, and safety of these areas influence how people perceive and utilise them (Ward Thompson, 2011). Moreover, the perception of greenery is subjective, shaped by cultural, social, and individual differences (Seaman et al., 2010).

1.2.2 Mental Wellbeing

Mental wellbeing refers to a positive state of psychological functioning that encompasses both emotional and cognitive aspects of life. According to the WHO (2001), it is “a state in which an individual realises their own abilities, can cope with normal stresses of life, can work productively, and is able to contribute to their community.” Unlike mental illness, which refers to diagnosable clinical disorders such as depression or schizophrenia, mental wellbeing is a broader construct that includes life satisfaction, happiness, self-esteem, resilience, and social connectedness (Keyes, 2002). It is therefore possible for individuals to experience mental wellbeing even in the presence of mental health conditions, and vice versa.

The focus on mental wellbeing is particularly important because it frames mental health as a continuum rather than a binary state of illness versus absence of illness (Huppert, 2009). This perspective shifts public health priorities toward promoting positive mental states and preventing illness, rather than solely treating disorders after they occur.

1.3 Statement of the Problem

The modern world faces a paradox. While evidence increasingly demonstrates that Environmental greenery provides significant psychological and social benefits, urban lifestyles are often characterised by limited and unequal access to these environments (Wolch et al., 2014). Urban sprawl, infrastructural development, and economic inequalities mean that for many individuals, opportunities to engage with nature are diminishing.

At the same time, mental health conditions are rising to unprecedented levels, with depression and anxiety now among the top contributors to years lived with disability (WHO, 2022). Traditional clinical treatments, while essential, are costly and often inaccessible in low- and middle-income countries. Thus, there is growing interest in preventive, low-cost, and widely accessible interventions, such as integrating and promoting green spaces in urban planning (Barton & Rogerson, 2017).

Despite this, significant gaps remain in the literature. While numerous studies suggest that contact with green spaces is associated with better mental wellbeing (Hartig et al., 2014; Twohig-Bennett & Jones, 2018), questions remain regarding the mechanisms through which these benefits are realised, such as physical activity, social cohesion, and attention restoration. Further uncertainty surrounds the relative importance of the quantity versus the quality of green spaces, as well as potential variations across cultural, socioeconomic, and demographic

groups. Without addressing these gaps, efforts to design equitable and effective interventions may fall short.

1.4 Aim and Objectives of the Study

Aim

The aim of this study is to investigate the relationship between environmental greenery and mental wellbeing, with the goal of informing public health interventions and urban planning strategies.

Objectives

1. To critically review existing literature and theoretical frameworks linking environmental greenery to mental wellbeing outcomes.
2. To examine the association between availability and types of environmental greenery, and mental wellbeing indicators.
3. To assess how demographic and socioeconomic factors mediate or moderate the relationship between environmental greenery and mental wellbeing.
4. To explore the mechanisms, such as social interaction, and physical activity, through which environmental greenery affect mental wellbeing.
5. To provide evidence-based recommendations for urban planners and policymakers to design equitable green infrastructures that promote population wellbeing.

Hypothesis

It is hypothesised that individuals with greater exposure to environmental greenery will report higher levels of mental wellbeing compared to those with limited or no exposure.

1.5 Significance of the Study

This research is significant for several reasons. First, it addresses a major public health concern, which is the rising burden of mental health conditions globally, especially in urbanised societies. By focusing on everyday environments rather than clinical interventions, this study identifies potentially low-cost and sustainable strategies for enhancing mental wellbeing.

Second, it contributes to interdisciplinary knowledge by integrating insights from psychology, public health, and environmental studies. While existing studies have often focused on physical health benefits of green spaces (e.g. reduced cardiovascular risk), fewer have explored their impact on mental wellbeing in a holistic manner (Twohig-Bennett & Jones, 2018).

Third, this study highlights the equity dimension of green space provision. Unequal distribution of green spaces may exacerbate health inequalities, as disadvantaged populations often have the least access despite facing higher risks of poor mental health (Mitchell & Popham, 2008). By addressing these disparities, the study supports the design of policies that promote fairness and inclusion in public health.

Finally, this research may offer practical applications for urban planners and policymakers by demonstrating how investments in green infrastructure can serve not only environmental sustainability but also population wellbeing.

1.6 Knowledge Gap and Contribution to Existing Knowledge

Despite increasing research, several knowledge gaps remain. Many studies have focused on the physical health benefits of green spaces, such as reduced obesity, improved air quality, and lower cardiovascular risks (Maas et al., 2009). By contrast, mental wellbeing has received comparatively less systematic attention, particularly in terms of positive indicators such as happiness, resilience, and life satisfaction.

Furthermore, most existing studies are concentrated in high-income countries, particularly Europe and North America, where cultural and environmental contexts may not reflect global realities (Rigolon, 2016). Low- and middle-income countries, where urbanisation is accelerating most rapidly, remain underrepresented in the literature. Additionally, little is known about how quality, safety, and cultural perceptions of green spaces influence wellbeing, beyond simple measures of green space quantity (Ward Thompson, 2011).

This study aims to fill these gaps by examining not only the presence of green spaces but also the interlinking mediators between mental wellbeing and green spaces. By considering demographic, cultural, and socioeconomic moderators, it contributes a more nuanced understanding of how green spaces influence mental wellbeing across different populations. In doing so, it adds to the evidence base that can guide both public health strategies and sustainable urban planning.

1.7 Overview of Methodology

A cross-sectional study of Maltese adults targeting a sample of 600 recruited via higher-education, workplace, and primary-care settings. Mental wellbeing was measured with WHO-5 (0–100). Environmental greenery exposures (grassland, tree canopy, cropland; total

greenery) were computed within 300 m and 900 m buffers around residential and workplace/education street centroids using ArcGIS Pro. Analyses included bivariate correlations and multivariable hierarchical regression.

Chapter 2: Literature Review

2.1 Introduction

The relationship between the natural environment and human mental wellbeing has become a prominent focus of interdisciplinary research, driven by rising urbanisation, environmental degradation and public health concerns (Hartig et al., 2014; Gascon et al., 2015). Whether in the form of urban parks, community gardens, trees, or natural vegetation, green spaces are increasingly recognised as vital components of the built environment that can positively influence mental health outcomes (Dadvand et al., 2016). These benefits are not limited to aesthetic pleasure, but rather encompass a range of psychological, physiological, and social processes that contribute to improved quality of life (Markevych et al., 2017).

Understanding how and why environmental green cover affects mental wellbeing is essential for informing urban planning, environmental policy, and public health strategies. Evidence identifies several key pathways through which these benefits occur. These include stress reduction (Kaplan & Kaplan, 1989), promotion of physical activity (Astell-Burt et al., 2013), facilitation of social cohesion (Maas et al., 2009), and mitigation of environmental stressors such as air and noise pollution (Yang et al., 2023).

However, the strength and nature of these relationships can vary significantly. Factors such as green space quality, accessibility, biodiversity, and socio-demographic context (Mavoa et al., 2021; Yue et al., 2022) influence the extent to which mental wellbeing benefits are realised. This variability underscores the need for a nuanced and context-sensitive approach to both research and practical implementation.

This chapter synthesizes current evidence on the association between environmental greenery and mental wellbeing in adult populations. It examines how green space is measured and explores the mechanisms through which benefits are realized. It also identifies key mediators of these effects.

2.2 Methodology of the Literature Review

To ensure a systematic approach, the literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Checklist (Page et al., 2021). The PICO framework was pivotal in ensuring that this systematic review remained focused, structured, and methodologically sound. PICO, which stands for Population, Intervention, Comparison, and Outcome, is widely recognised as a reliable framework for formulating research questions and objectives in systematic reviews and evidence-based practice (Capili, 2020). Its application enabled the clear identification of the review's scope, minimised ambiguity, and guided the search strategy.

The guiding research question underpinning this review was:

"When compared to low or no environmental greenery exposure, how does exposure to high levels of environmental greenery affect mental wellbeing among adults?"

Each component of the PICO framework was operationalised as follows:

Population:

The focus of this review was the *adult population*, defined as individuals aged 18 years and above. Adults were selected because they typically exhibit greater autonomy over their residential environments and lifestyle choices compared to children or adolescents, making them an appropriate group for examining the independent effects of greenery exposure (Wang

et al., 2021). Furthermore, adult populations are more frequently studied in research addressing the built environment and mental health, which provides a stronger evidence base for comparative analysis. In alignment with the inclusion and exclusion criteria (see Table 4), studies involving children or adolescents aged 17 years or younger were excluded, as their mental wellbeing outcomes and environmental exposures may differ substantially from those of adults (Pasanen et al., 2023). This is because children and adolescents are in distinct developmental stages, with mental wellbeing strongly influenced by family, school, and peer environments (Patel, V 2007; Reiss, F 2013). Additionally, young people's mobility patterns and exposure to environmental greenery are mediated by parents, schools, and community infrastructure, leading to different exposure pathways than adults (Markevych et. al., 2017; Feng & Astell-Burt, 2017).

Intervention:

The intervention examined was *passive exposure to environmental greenery*. This encompasses a broad range of interactions with natural or planted green environments, including neighbourhood green spaces, urban tree canopies, vegetative land cover, and parks (Dadvand et al., 2016; Ekkel & de Vries, 2017). Exposure was not limited to deliberate or active engagement (e.g., structured exercise or recreational activities). It also included incidental or passive experiences such as viewing greenery from a window, walking through tree-lined streets, or living near vegetated areas (Ulrich, 1984; Kaplan, 1995). Objective measures of exposure used in the included studies commonly relied on geospatial data such as the Normalized Difference Vegetation Index (NDVI) and Geographic Information Systems (GIS), which quantify vegetation density and proximity (Rugel et al., 2017; Liu et al., 2019).

Comparison:

The comparison group consisted of individuals with *low or no exposure to environmental greenery*. This group typically resided in areas with sparse green infrastructure, minimal vegetative cover, or limited access to parks and urban green spaces. The inclusion of this comparator was essential for evaluating the relative benefits of high environmental greenery exposure and allowed for a clearer attribution of observed differences in mental wellbeing outcomes to environmental factors (Berg et al., 2010; Astell-Burt et al., 2019). This approach also enabled the review to account for environmental inequalities, such as socio-economic disparities in access to green spaces, which can significantly influence health outcomes (Yue et al., 2022).

Outcome:

The primary outcome of interest was *mental wellbeing*, a multidimensional construct encompassing both positive indicators (e.g., life satisfaction, improved mood, enhanced quality of life) and reductions in negative indicators (e.g., psychological distress, depression, anxiety) (Markevych et al., 2017; Kruize et al., 2020). The included studies used a range of validated subjective and objective measures to assess mental wellbeing, including standardised questionnaires, self-report scales, and clinical assessments. This inclusive approach ensured a comprehensive synthesis of evidence reflecting the complex nature of mental wellbeing outcomes.

The literature review was guided by the PRISMA 2020 Checklist (Page et al., 2021). The PICO framework was adopted to help formulate the research question and objectives (Capili Bernadette, 2020), and is summarised in Table 1.

Table 1: The Application of the PICO Framework to Formulate the Research Question

Population	Adult population
Intervention	Passive Exposure to Environmental Greenery
Comparison	Low or no exposure to environmental greenery
Outcome	Improved Mental Wellbeing

2.3 Search Strategy

The sources of information listed in Table 2 were considered relevant to the research topic and were used to conduct advanced searches. To assess the risk of bias in the included studies, the ROBIS tool was utilised (Whiting et al., 2016). The findings were then synthesised using a qualitative (thematic) approach.

Table 2: A list of information sources used for advanced searches of studies

Number	**Information Source**
1	APA PsycINFO
2	CINAHL Complete
3	Environment Complete
4	GreenFILE
5	Medicine Complete
6	ProQuest Public Health
7	PubMed
8	Scopus
9	Google Scholar
10	HyDi

To identify the most appropriate databases relevant to the research questions, initial searches were conducted using Google Scholar and the University of Malts's Hybrid Discovery (HyDi) platform. After identifying the most suitable databases, searches were carried out in each individual database. This approach ensured a comprehensive search to capture the most relevant available literature. The search terms used are summarised in Table 3 below.

Table 3: Search terms used in the literature search

Theme	Combined Search Terms
Environmental greenery	Green space* OR Green cover OR Urban green space* OR Green infrastructure* OR Vegetation index* Or Normalised Difference Vegetation Index* OR NDVI OR Nature OR Natural environment OR Green environment

The literature review included academic articles published in peer-reviewed journals, such as meta-analyses, systematic reviews and primary research studies. Sources such as case reports, book chapters, and other non-peer-reviewed materials were excluded.

2.4 Eligibility Criteria

The literature review was conducted between 8th March and 18th April 2025. Studies published between 2010 and 2025 were included. The inclusion and exclusion criteria applied are summarised in Table 4 below.

Table 4: The inclusion and Exclusion Criteria applied to retrieve studies

Criteria	Inclusion	Exclusion
Participants	Adults aged 18 years and above	Children and adolescents aged 17 years and under
Intervention	Neighbourhood environmental green cover, green spaces, Normalized Difference Vegetation Index, urban greenery	Studies not focusing on green environments within the neighbourhood
Outcome	Studies that include measures or indicators of mental wellbeing	Studies that do not assess any mental wellbeing indicators
Study Design	Quantitative and qualitative, mixed-methods primary research	Conference proceedings, editorials, non-primary research
Language	English	Non-English studies without available translation
Publication year	Studies published between 2010 and 2025	Studies published before 2010

2.5 Screening of Articles

A total of 955 records were initially retrieved from all databases listed in Table 2. Subsequently, 217 duplicate records were removed, resulting in 738 unique records available for title and abstract screening. These records were screened against the predefined inclusion and exclusion criteria outlined in Table 4, through which 685 records were excluded for not

meeting the eligibility parameters. The full texts of the remaining 53 records were then subjected to detailed assessment, from which 25 studies were ultimately deemed eligible for inclusion. This selection process is illustrated in Figure 1, and a comprehensive overview of the included studies is provided in Appendix 8.

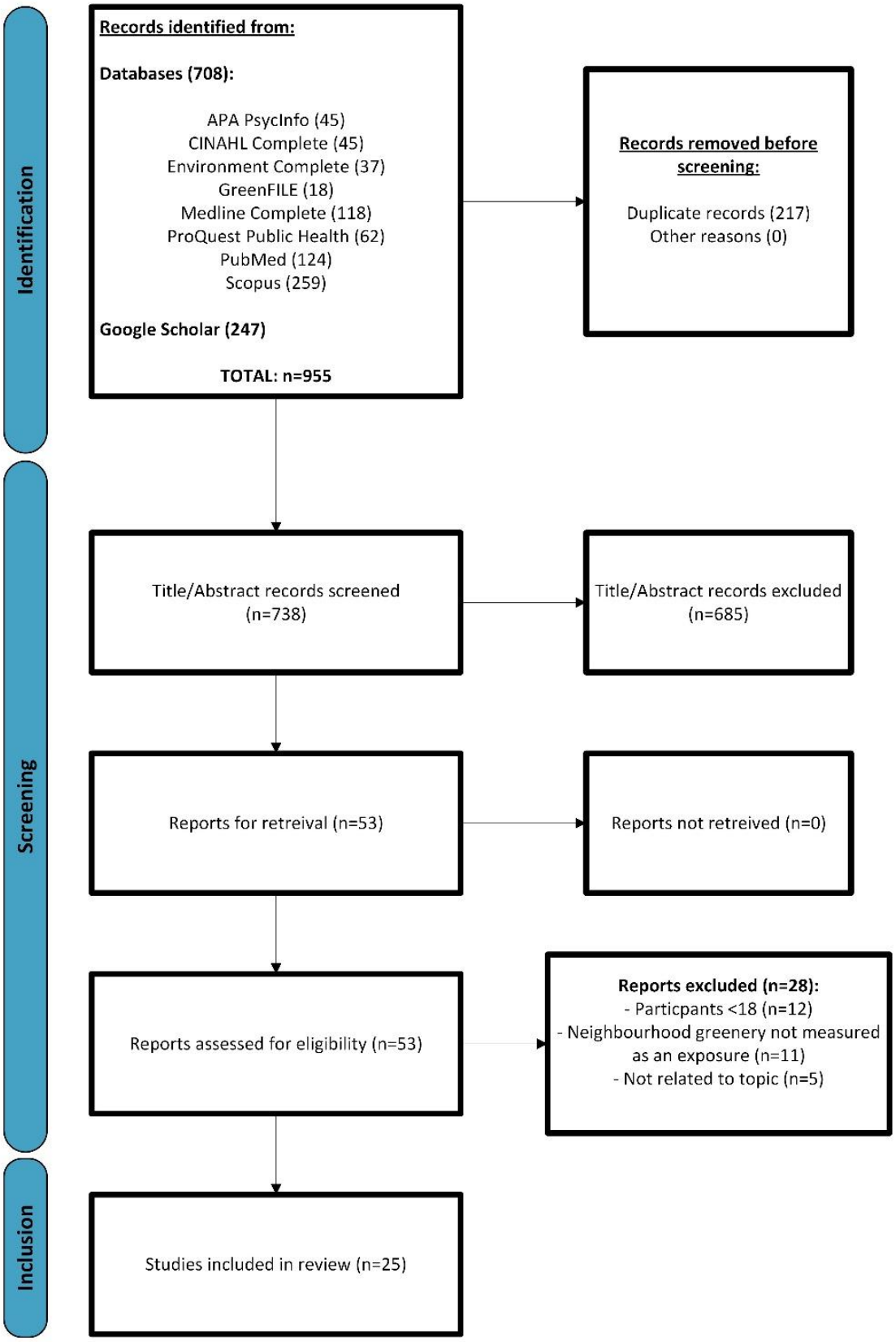

Figure 1: PRISMA 2020 Flow Diagram illustrating the process of screening and retrieval of articles.

2.6 Thematic Analysis and Synthesis of Literature Review Findings

A thematic analysis was employed to synthesise the findings from the 25 included studies. This approach enables the identification of common patterns and conceptual frameworks across diverse research settings. The results are organised under themes that reflect the conceptual insights into the relationship between environmental greenery and mental wellbeing.

2.7 Mental Wellbeing Measures

The included studies employed a broad array of instruments to capture mental wellbeing, reflecting the construct's multidimensional and context-dependent nature. Measures varied from general self-reported mental wellbeing indices to validated clinical scales targeting specific mental health outcomes such as depression, anxiety, and psychological distress. While providing breadth, this heterogeneity, poses challenges for direct comparison across studies.

Subjective measures were the most frequently used, often relying on standardised questionnaires and self-reported surveys. Common tools included the General Health Questionnaire (GHQ-12) (van den Berg et al., 2010; Astell-Burt et al., 2013), which screens for psychological distress, and the Warwick-Edinburgh Mental Well-being Scale (WEMWBS), which captures both hedonic and eudaimonic aspects of wellbeing (Liu et al., 2019). The WHO-5 Wellbeing Index, a five-item scale, was applied in studies to assess mental wellbeing (Pasanen et al., 2023). Depression-specific instruments such as the Center for Epidemiologic Studies Depression Scale (CES-D) (Yue et al., 2022) and the Patient Health Questionnaire (PHQ-9) (Bakhtsiyarava et al., 2024) were common, especially in epidemiological surveys aiming to identify clinically relevant depressive symptoms. Anxiety measures appeared less frequently,

with the Hospital Anxiety and Depression Scale (HADS) used in the study of Kruize et al. (2020) to evaluate both anxiety and depression symptoms.

Objective or clinician-administered assessments, though less frequently employed, conferred greater methodological robustness than self-reported surveys. For example, Dadvand et al. (2016) incorporated mental health registry data to corroborate self-reported findings, reducing self-report bias. Similarly, Astell-Burt & Feng (2019) linked survey responses to follow-up clinical records in a longitudinal design, enabling the identification of temporal associations between green space exposure and mental health trajectories.

In addition to symptom reduction, several studies assessed positive mental wellbeing dimensions, including life satisfaction, social connectedness, and vitality. Instruments such as the Satisfaction with Life Scale (SWLS) (Wang et al., 2021) were used alongside single-item life satisfaction measures embedded in national health surveys (Akpinar et al., 2016). Other indicators, such as sense of community and neighbourhood satisfaction, were incorporated particularly in Chinese studies (Liu et al., 2019; Yue et al., 2022), reflecting cultural conceptualisations of mental wellbeing that emphasise collective harmony and place attachment.

A recurring methodological consideration was the timeframe of measurement. Cross-sectional designs often assessed current or recent mental wellbeing (e.g.past two weeks), while longitudinal studies evaluated changes over extended periods, capturing both immediate and sustained impacts of environmental greenery exposure. For example, Astell-Burt & Feng (2019) tracked wellbeing changes over several years, offering insights into the cumulative benefits of sustained exposure.

Lastly, the diversity in mental wellbeing outcome measures reflected both the conceptual breadth of mental wellbeing and the influence of cultural and policy contexts. For example, studies in China (Liu et al., 2019; Yue et al., 2022) often integrated social harmony and neighbourhood satisfaction as mental wellbeing indicators, whereas European studies (van den Berg et al., 2010; Kruize et al., 2020) emphasised psychological distress reduction and life satisfaction. This reflects the differing priorities in public health and urban planning frameworks across different continents and countries.

2.8 Objective Measures of Environmental Greenery

Objective measures for assessing nature exposure typically focus on the quantification of environmental greenery in terms of size, density, type and accessibility using standardised methods that minimise recall bias (Ekkel and de Vries, 2017; Kajosaari and Pasanen, 2021; Huang et al., 2022;). These measures are central to environmental epidemiology, as they provide consistent metrics across populations and time periods. Common tools include Geographic Information Systems (GIS), high-resolution satellite imagery, remote sensing technologies, and vegetation indices such as the NDVI. NDVI is a measure of vegetation greenness derived from land surface reflectance in the visible and near-infrared portions of the spectrum. Its values range from −1 to 1, with positive and higher values representing greater photosynthetically active vegetation. Values near zero correspond to urban or barren land, and negative values denote water (Pettorelli et al., 2005). These methods enable researchers to capture spatial patterns of vegetation and link them to health outcomes with precision.

Callaghan et al. (2021) reported that definitions of “urban green space” in the literature typically includes publicly accessible parks, sports fields, community gardens, cemeteries,

natural meadows, protected areas, woodlands, and shrublands. Private gardens were often excluded from this definition unless captured in NDVI calculations, which measures vegetation reflectance regardless of private land ownership.

The geographic unit of analysis varied widely among studies, which has implications for the scale and specificity of assessment of environmental greenery exposure. Larger administrative units such as zip codes (Akpinar et al., 2016) provided broad exposure estimates but may have masked local variations. More precise approaches employed radial buffers around participants' residences. Examples included 1 km (Astell-Burt et al., 2013), 1.6 km (Astell-Burt & Feng, 2019), 300 m (van den Berg et al., 2017), or both 1 km and 3 km buffers (van den Berg et al., 2010). Some studies employed multiple buffer distances to capture varying scales of exposure; Yue et al. (2022) used both 500 m and 1 km NDVI buffers, Dadvand et al. (2016) calculated NDVI averages at 100 m, 300 m, and 500 m, while Bakhtsiyarava et al. (2024) applied 250 m high-resolution land cover classifications. Such variation reflects ongoing debates about the appropriate spatial scale at which environmental greenery most strongly influences mental wellbeing.

Classification of environmental greenery type also differed. Akpinar et al. (2016) distinguished between aggregated "simply green" areas and specific land covers such as urban green, forest, rangeland, agricultural land, and wetland. Astell-Burt & Feng (2019) analysed distinct types of environmental greenery including tree canopy, grass, and low-lying vegetation, as well as the aggregated green space, which is the combination of all the distinct types of environmental greenery included in the study. Analysing distinct types of environmental greenery acknowledges that vegetation type may influence benefits differently.

Van den Berg et al. (2010) incorporated urban green, agricultural land, forests, and nature conservation areas into their green exposure metrics.

The above-mentioned metrics were retrieved from datasets and sources such as national and regional land cover databases, which were widely used to categorise and calculate the extent of environmental greenery (Liu et al., 2019; Bakhtsiyarava et al., 2024). These were often integrated into GIS workflows to provide precise spatial metrics. NDVI, derived from satellite-based spectral reflectance data, has been widely used to measure vegetation greenness and density. Studies have linked higher vegetation density to improved mental health outcomes (Dadvand et al., 2016; Rugel et al., 2017; Astell-Burt et al., 2019). The choice of satellite platform (e.g., Landsat with 30 m resolution versus MODIS with 250 m resolution) potentially affected the granularity of these estimates and the strength of observed associations.

Several studies advanced objective measurement by combining NDVI with contextual datasets such as census demographics or socioeconomic indices, enabling researchers to account for confounding factors and refine exposure estimates (Liu et al., 2019; Bakhtsiyarava et al., 2024).

Other objective metrics included mean tree canopy density from aerial imaging, urban park density per capita, euclidean distance to the nearest green space, and kernel density mapping to visualise the distribution of green patches (Kruize et al., 2020; Callaghan et al., 2021; Fisher et al., 2022). For instance, Kruize et al. (2020) measured the percentage of environmental greenery within 300 m of residences and assessed proximity to formal parks to capture both availability and access, as well as passive exposure.

Empirical findings consistently showed that greater objectively measured environmental greenery availability correlates with better mental wellbeing outcomes. Akpinar (2016) linked higher total environmental greenery coverage to higher self-reported mental health, while van den Berg et al. (2010) found that proximity to environmental greenery buffered the negative effects of stressful life events. Spatial heterogeneity also plays a role. This is demonstrated in the study by Callaghan et al. (2021), reporting stronger associations in outer London compared to the urban core.

Although these objective measures reduce recall bias and enable cross-study comparisons, they have limitations. They do not capture subjective perceptions of quality, safety, or usability, which can influence actual engagement and health outcomes. Kruize et al. (2020) and Fisher et al. (2022) emphasize that while spatial availability is important, environmental greenery that is poorly maintained or inaccessible may not yield mental health benefits. Consequently, many researchers increasingly advocate integrating objective environmental greenery measures like NDVI and GIS-derived land cover with subjective assessments to obtain a holistic understanding of environmental greeneryimpacts on mental wellbeing (Dzhambov et al., 2018; Callaghan et al., 2021).

2.9 Psychological Benefits of Green Exposure

Exposure to natural environments has been consistently identified as an important determinant of physical and mental wellbeing (Hartig et al., 2014; Denier & Mudu, 2021). Multiple studies included in this review demonstrate that contact with nature exerts diverse psychological benefits, including reductions in stress, improvements in mood, prevention of depressive symptoms, and restoration of cognitive functioning (Markevych et al., 2017; Liu et al., 2019; Kajosaari & Pasanen, 2021; Bijnens et al., 2022;).

These effects are underpinned by established theoretical frameworks such as the Stress Reduction Theory (SRT) and the Attention Restoration Theory (ART). SRT posits that exposure to natural environments can diminish psychological and physiological stress through positive affective responses and the attenuation of negative emotions (Ulrich, 1984; Tyrväinen et al., 2014). ART, in contrast, suggests that nature's effortless capacity to hold attention allows recovery from directed attention fatigue, thereby restoring cognitive capacities (Kaplan, 1995).

Empirical evidence from the included studies support these frameworks. Akpinar et al., (2016) found that higher neighbourhood environmental greenery was associated with improved self-reported mental health, while Berg et al. (2010) demonstrated that availability of environmental greenery buffered the negative impact of stressful life events. Similarly, Dadvand et al. (2016) and Astell-Burt et al. (2019) demonstrated that residential greenness, quantified through NDVI, was inversely associated with psychological distress and depressive symptoms in adults. These findings have been corroborated by studies using alternative measures of environmental greenery exposure. For example, Huang et al. (2022) and Callaghan et al. (2021) observed that the presence of street greenery and urban parks contributed significantly to self-rated mental wellbeing across various socio-demographic groups.

Beyond general greenery, several studies highlighted the influence of specific types and qualities of environmental greenery. Fisher et al. (2022) and Kruize et al. (2020) found that tree canopy cover is particularly beneficial, with exposures to ≥30% tree canopy being associated with reduced incidence of psychological distress. Likewise, studies by Pasanen et al. (2023) and Bijnens et al. (2022) emphasised that subjective perceptions, such as satisfaction with accessibility, safety, biodiversity, and recreational potential, are strong predictors of mental

wellbeing, in some cases exceeding the explanatory power of objective greenness metrics. In Guangzhou, Liu et al. (2019) reported that neighbourhood greenness had a positive association with mental wellbeing, moderated by perceived quality and accessibility of these spaces.

Even small-scale interventions may also deliver meaningful benefits. Kondo et al. (2018) observed that greening vacant lots led to significant reductions in psychological distress in low-income urban areas. Similar patterns were observed by Akpinar (2016) and Wang et al. (2019), where modest increases in residential greenness were associated with higher life satisfaction and fewer depressive symptoms. These findings suggest that both large-scale urban planning and small, targeted greening initiatives have roles to play in enhancing mental wellbeing.

Psychological benefits of exposure to environmental greenery may be mediated by several mechanisms and are discussed in further details in section 2.10. Environmental greenery can mitigate harmful exposures by improving air quality, reduced urban heat, and noise buffering (Jennings et al., 2016; Yue et al., 2022). They also build individual and community capacities by promoting physical activity and encouraging social cohesion. Urban parks and community gardens provide spaces for leisure, exercise, and informal social interaction, which have been shown to reduce feelings of loneliness and improve life satisfaction.

2.10 Mediators between Environmental Greenery and Mental Wellbeing

A growing body of evidence from the included studies indicates that the association between environmental greenery and mental wellbeing is not simply a direct cause–effect relationship, but rather operates through a network of interrelated environmental, behavioural, and social mechanisms. These mediating pathways help explain why, how, and

for whom environmental greenery exert mental health benefits, while also accounting for the variability observed across settings and populations.

Core mediators identified in this review include increased physical activity (Astell-Burt et al., 2013; Yue et al., 2022), enhanced social cohesion and social support networks (Kruize et al., 2020; Qin et al., 2021), and mitigation of environmental stressors such as air and noise pollution, and the urban heat island effect (Yue et al., 2022; Yang et al., 2025). Other pathways operate indirectly, for example by reducing the prevalence of chronic diseases (Wang et al., 2021; Bakhtsiyarava et al., 2024) or by improving perceptions of neighbourhood safety and quality (Liu et al., 2019; Callaghan et al., 2021).

These pathways often interact. For example, vegetation can improve ambient temperatures, improve air quality, and buffer environmental noise, thereby reducing cumulative environmental burdens that negatively impact psychological health. Additionally, exposure to environmental greenery can indirectly support mental wellbeing by promoting healthier living environments and lowering the risk of chronic diseases such as cardiovascular and metabolic disorders, which are known to be associated with poor mental health outcomes (Liu et al., 2019). Additionally, improved air quality in greener areas may encourage more outdoor physical activity, which can also foster social interactions. Collectively, the evidence highlights that greenery influences mental wellbeing through a complex web of environmental, behavioural, and social mechanisms.

Recognising these mediators is essential not only for interpreting epidemiological findings, but also for informing targeted urban planning and public health interventions. Understanding whether mental wellbeing benefits arise primarily through environmental modification, behavioural change, or social processes can guide investment in the most efficient design and

maintenance strategies for green infrastructure. The following subsections explore these mediating mechanisms in detail, drawing on both objective measures and subjective perceptions reported in the reviewed studies.

2.10.1 Heat Urban Effect

Urban green spaces play a significant role in mitigating the urban heat island (UHI) effect, a phenomenon where densely built environments trap heat, resulting in elevated air and surface temperatures compared to surrounding rural areas. This temperature difference can be substantial; up to 7–10°C in some cities during summer peaks. This places considerable strain on physical and mental wellbeing (Yang et al., 2025). The presence of trees, grass, and vegetation reduces surface and ambient temperatures through shading, evapotranspiration, and reduced heat absorption by impervious surfaces, thereby creating cooler and more comfortable microclimates (Bakhtsiyarava et al., 2024).

The psychological implications of heat stress are increasingly recognised. Prolonged exposure to high ambient temperatures is linked to irritability, reduced cognitive performance, sleep disruption, and heightened risks of anxiety and depressive symptoms (Kruize et al., 2020; Qin et al., 2021). Vulnerable groups, particularly older adults, individuals with pre-existing cardiovascular or mental health conditions, and those living in poorly insulated housing are disproportionately affected. By lowering ambient temperatures, environmental greenery can buffer against these impacts, helping to preserve mental equilibrium during periods of extreme heat (Bakhtsiyarava et al., 2024).

Evidence from the reviewed studies demonstrates these benefits in practice. For instance, Yue et al. (2022) and Liu et al. (2019) highlight that street-level greenery and tree canopy coverage were associated with not only cooler neighbourhood microclimates but also higher

self-rated wellbeing in older urban residents. This aligns with international evidence showing that tree-lined streets and shaded parks reduce physiological markers of heat stress, such as elevated heart rate and cortisol levels, which in turn relate to lower perceived stress and better mood (Jennings et al., 2016; Kondo et al., 2018).

Importantly, the cooling effect of greenery extends beyond thermal comfort to influence behaviour and social interaction. Cooler microclimates increase the usability of outdoor spaces, encouraging physical activity, recreation, and casual social encounters that contribute to social cohesion and resilience (Kruize et al., 2020). In this way, the mitigation of the UHI effect by vegetation does not operate as an isolated pathway. It interconnects with other mediators such as physical activity and social cohesion, amplifying their combined benefits for mental wellbeing.

In planning contexts, these findings underscore the value of strategically increasing tree canopy cover and integrating vegetated surfaces into high-density urban places, where UHI effects are most pronounced. Studies suggest that even modest greening interventions, such as planting street trees or installing green roofs, can meaningfully lower ambient temperatures, making outdoor environments safer and more inviting during heatwaves, with downstream benefits for psychological wellbeing (Yang et al., 2025).

2.10.2 Socio-demographic Variables

Socio-demographic and social variables, including socioeconomic status (SES), age, gender, education level, income, and cultural background play a decisive role in shaping both access to environmental greenery and the extent to which their mental wellbeing benefits are realised. These factors influence exposure patterns, perceptions of safety and quality, and

the types of activities undertaken in green environments (Mitchell & Popham, 2008; Astell-Burt et al., 2013).

Evidence from the included studies indicates that individuals from higher SES backgrounds are more likely to live in neighbourhoods with well-maintained, safe, and biodiverse environmental green spaces, enabling more frequent and restorative contact with nature (Kruize et al., 2020; Bakhtsiyarava et al., 2024). Such environments not only promote physical activity and social interaction but also reduce exposure to urban stressors like noise and air pollution, further improving mental wellbeing (Wang et al., 2021).

In contrast, disadvantaged populations often face structural barriers access to environmental greenery. The review of Callaghan et al., (2021) found that parks and natural areas in deprived urban neighbourhoods tend to be of lower quality, less accessible, and lacking in key amenities. Brennan et al. (2017) highlight that these inequities can be compounded by safety concerns and inadequate maintenance, deterring regular use. In some cases, the available green spaces were located in areas with high traffic density, industrial activity, or environmental hazards, which can undermine any potential health benefits (Yue et al., 2022).

Age-related differences are consistently reported. Older adults may derive significant psychological benefits from greenery due to its potential to support mobility, social interaction, and protection against loneliness (Wang et al., 2021; Yue et al., 2022). However, mobility limitations and inadequate infrastructure (e.g. lack of seating, lighting, or safe paths) can restrict use (Sugiyama et al., 2008). Younger adults may engage more in physical activity and sports in green spaces, linking them to stress reduction and improved mood, though

competing demands such as work or childcare can reduce their engagement (Kruize et al., 2020).

Gender also moderates the relationship between environmental greenery and mental wellbeing. Women often report stronger psychological restoration from exposure to environmental greenery, partly due to activity patterns such as walking, childcare, and socialising (Richardson & Mitchell, 2010). However, perceptions of personal safety, particularly in poorly lit or secluded areas, can deter use, limiting mental wellbeing benefits (Kuo & Sullivan, 2001).

Ethnic and cultural differences in green space use and perception further shape outcomes. Callaghan et al. (2021) cite findings from McEachan et al. (2018) showing that access to environmental greenery was significantly associated with reduced behavioural difficulties among South Asian children in deprived UK neighbourhoods, but not among their white British peers. This suggests that cultural, social, or behavioural norms may mediate the relationship between exposure to environmental greenery and mental health.

Poor-quality green spaces that lack adequate maintenance, safety, and amenities are less likely to be used and may even increase perceptions of insecurity, particularly in areas with high crime rates. These inequities reduce the likelihood of engaging in outdoor recreational activities, which are known to support both physical and mental wellbeing. Studies have shown that lower-income communities often have fewer parks, and the parks they do have may be smaller, overcrowded, or located in areas affected by environmental hazards such as noise or air pollution, further diminishing their potential benefits (Yang et al., 2025).

These disparities have been observed globally. In urban areas across Latin America, Asia, and Europe, lower SES neighbourhoods consistently report reduced access to green

infrastructure and fewer opportunities to benefit from the restorative effects of nature (Wang et al., 2021; Yue et al., 2022). For example, Yue et al. (2022) found that in Chinese cities, older adults living in low-income communities had lower exposure to street-level greenery and poorer perceptions of their neighbourhood environment, both of which were associated with worse mental health outcomes.

Overall, socio-demographic and social factors not only modify the mental health impacts of environmental greenery but also determine the likelihood of accessing and engaging with such environments. Addressing these disparities requires targeted interventions, such as community-led greening projects, culturally-sensitive designs, and safety improvements, to ensure equitable distribution of benefits across age, gender, socioeconomic strata, and cultural groups. Urban health strategies should therefore integrate an equity lens to maximise the mental wellbeing potential of green infrastructure. It is, however, important that this is done in a sustainable and nature-sensitive manner (Kabisch et al., 2016; Frumkin et al., 2017).

2.10.3 Social Cohesion

Social cohesion is an important pathway linking exposure to environmental greenery with improved mental wellbeing. Environmental greenery act as informal community hubs, providing venues for social interaction, collective social activities, and the development of community trust and mutual support networks (Kruize et al., 2020; Wang et al., 2021). These are essential for psychological resilience (Kruize et al., 2020). Such environments can buffer against the negative effects of social stressors such as crime, economic hardship, and social isolation (Qin et al., 2021; Wang et al., 2021).

The design, quality and accessibility of environmental greenery significantly influence their capacity to promote social cohesion. Features such as the availability of benches, shaded

areas, well-maintained paths, and well-lit open areas encourage people to linger, interact and engage in organised or spontaneous activities (Yang et al., 2025). Conversely, environmental greenery that is poorly maintained or perceived as unsafe may discourage use, particularly among vulnerable groups such as older adults, women, and children, thereby undermining opportunities for social connections (Yue et al., 2022).

Findings from the included studies highlight that neighbourhood greenery is often positively associated with measures of social cohesion. For instance, Kruize et al. (2020) found that residents living in greener areas reported stronger neighbourhood ties and greater perceived social support. Similarly, Wang et al. (2021) reported that urban residents with access to high-quality, well-distributed green space expressed higher levels of community satisfaction and engagement.

The benefits of environmental greenery for social cohesion extend across cultural contexts. In European neighbourhoods, small urban parks have been shown to facilitate casual social exchanges that still contribute to psychological resilience (Jennings & Bamkole, 2019). In Asian cities, Yue et al. (2022) observed that the presence of greenery in residential areas was associated with higher neighbourhood satisfaction, which mediated improvements in mental wellbeing among older adults.

Well-connected and socially cohesive communities are also more likely to advocate for the preservation and enhancement of their local green spaces, creating a positive feedback loop. Stronger social networks support the maintenance and protection of green environments, which in turn reinforce community bonds (Qin et al., 2021).

2.10.4 Physical Activity

Physical activity is one of the most consistently identified behavioural mediators in the relationship between environmental greenery exposure and mental wellbeing. Access to safe, well-maintained parks, trails, and green corridors facilitates opportunities for walking, jogging, cycling, and other forms of outdoor recreation, which are strongly associated with improved mood, reduced anxiety, and lower prevalence of depressive symptoms (; Kruize et al., 2020; Yang et al., 2025).

Findings from the included studies reinforce this link. Astell-Burt et al., (2013) reported that residents of greener neighbourhoods had a lower risk of psychological distress, with the effect partly explained by higher levels of physical activity. Yue et al. (2022) observed that in urban China, street-level greenery and park coverage were positively associated with recreational walking among older adults, which in turn predicted better self-reported mental health. Similarly, Wang et al. (2021) found that neighbourhood vegetation coverage encouraged daily outdoor movement, including walking as part of commuting or errands, which contributed to overall life satisfaction.

The restorative qualities of natural environments may further encourage people to be physically active. ART (Kaplan, 1995) suggests that engaging with nature can replenish cognitive resources, making physical activity more enjoyable and less mentally taxing. This synergy between restoration and movement has been described as “green exercise,” where the psychological benefits of nature and the physiological benefits of activity reinforce each other (Pretty et al., 2005).

Design factors influence the extent to which environmental greenery promote physical activity. Well-connected walking paths, adequate lighting, exercise facilities, and features such

as playgrounds or open lawns all contribute to sustained engagement (Kaczynski et al., 2008). However, poor maintenance, lack of safety, or environmental hazards such as high pollution levels can limit outdoor activity, even when green spaces are available (Yue et al., 2022).

Studies conducted across multiple contexts have demonstrated that residents in greener neighbourhoods are more likely to meet recommended physical activity levels compared to those in less green areas (Wang et al., 2021; Yue et al., 2022). For instance, Yue et al. (2022) found that in urban areas of China, higher levels of street-level greenery and park coverage were associated with increased recreational walking and other forms of physical activity, which subsequently improved older adults' mental health outcomes. Similarly, Wang et al. (2021) reported that neighbourhoods with higher vegetation coverage supported more frequent outdoor activity and walking as part of daily routines, reinforcing the health-promoting effects of green environments.

The presence of safe, accessible, and well-maintained green spaces can also motivate sustained engagement in physical activity. This is particularly important for long-term mental health benefits, which include improved cognitive function, reduced risk of depressive symptoms, and greater overall life satisfaction (Bakhtsiyarava et al., 2024). Design elements such as adequate lighting, walking paths, and facilities for recreation can increase the perceived safety and attractiveness of environmental greenery, thereby encouraging more consistent use (Kruize et al., 2020). Moreover, the combination of physical activity and exposure to natural environments has been shown to be synergistic, amplifying the psychological benefits of each independently (Yang et al., 2025).

Physical activity represents both a direct and synergistic mechanism by which environmental greenery improves mental wellbeing. Environments that are accessible,

aesthetically pleasing, and perceived as safe not only increase the likelihood of physical activity but also amplify its psychological benefits through the added restorative effects of nature.

2.10.5 Chronic Diseases

Environmental greenery may indirectly reduce the burden of chronic diseases through multiple interconnected pathways, including stress reduction, the promotion of physical activity, and improvements in air and noise quality. Prolonged exposure to stress is a known risk factor for numerous chronic conditions, such as cardiovascular disease, diabetes, and hypertension. The restorative effects of natural environments, including reductions in cortisol levels and improvements in autonomic nervous system balance, can mitigate these physiological stress responses and thereby support better long-term health outcomes (Kruize et al., 2020).

Environmental greenery also encourages regular physical activity, which is a critical preventive factor for chronic illnesses. Studies have shown that individuals living in greener neighbourhoods are more likely to engage in walking and other forms of outdoor exercise, reducing their risk for obesity, type 2 diabetes, and cardiovascular disease (Wang et al., 2021; Yue et al., 2022). These behaviours are further reinforced by safe, accessible, and well-maintained natural environments that motivate sustained engagement in physical activity (Bakhtsiyarava et al., 2024).

Environmental greenery can also improve environmental quality in ways that reduce risks of chronic disease. Vegetation can filter air pollutants such as fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), and ozone, all of which are associated with cardiovascular and respiratory illnesses (Nowak et al., 2014). Reductions in air pollution exposure not only improve respiratory and cardiac health but are also linked with lower rates of depression and

anxiety (Dzhambov et al., 2018). Similarly, Environmental greenery buffers environmental noise, which is another risk factor for cardiovascular disease and poor mental health, by absorbing and diffusing sound waves (Yang et al., 2025).

Vegetation also absorbs airborne particulate matter and acts as a buffer against traffic-related noise, both of which are associated with chronic systemic inflammation and worsened health outcomes (Dzhambov & Dimitrova, 2014; Yang et al., 2025). Reducing exposure to these environmental stressors can decrease the physiological burden on individuals with existing chronic conditions and lower the incidence of disease onset in the broader population.

Beyond prevention, environmental greenery can enhance the quality of life for individuals already living with chronic illnesses. Access to restorative environments can encourage light physical activity, reduce stress, and improve mood in patients managing long-term conditions (Maas et al., 2009). Some evidence even suggests that exposure to greenery can improve treatment adherence and recovery outcomes, as patients with access to natural views or environments may experience shorter hospital stays and require less pain medication (Ulrich, 1984; Li et al., 2020).

2.10.6 Residential Environment

The quality of the residential environment, including the availability, accessibility and type of environmental greenery, is crucial for promoting mental wellbeing. Well-maintained and safe green areas within residential neighbourhoods provide opportunities for regular use, and positively influence residents' perceptions of their surroundings, contributing to stronger community attachment and overall life satisfaction (; Kruize et al., 2020; Bakhtsiyarava et al., 2024). Conversely, poorly maintained or inaccessible green spaces can exacerbate feelings of neglect and insecurity, particularly in deprived areas where environmental quality is already

compromised (Yue et al., 2022). These disparities often overlap with broader socioeconomic inequalities, as lower-income communities tend to have fewer high-quality green spaces and more environmental hazards, which may amplify the mental health burden (Yang et al., 2025).

Poor housing conditions such as overcrowding and dampness are additional stressors within the residential environment. Overcrowded living conditions limit privacy and can contribute to chronic stress and social tension, while damp homes are linked with respiratory illness and poorer mental wellbeing, particularly in vulnerable groups (Pasanen et al., 2023). Access to nearby, restorative green spaces can provide relief from these conditions by offering opportunities for relaxation and escape, although the benefits may be diminished if the spaces are perceived as unsafe or poorly maintained (Yue et al., 2022).

Noise pollution, particularly from road, rail and air traffic, is another factor affecting residential quality. Chronic noise disrupts sleep, reduces the restorative quality of rest, and contributes to psychological distress (; Dzhambov & Dimitrova, 2014; Klompmaker et al., 2019). Environmental greenery can mitigate noise by serving as natural buffers that absorb and diffuse sound, creating quieter, more peaceful residential environments (Yang et al., 2025).

Neighbourhood safety also shapes how residents interact with local green spaces. Neighbourhood crime and perceived insecurity further influence the use of green spaces and can undermine social cohesion. Evidence suggests that greener neighbourhoods often report lower crime rates, partly because natural surveillance and community use of these spaces foster collective efficacy and social trust (Kruize et al., 2020; Qin et al., 2021).

Residential proximity to high-quality green spaces has also been associated with increased social cohesion, higher physical activity levels, and improved quality of life (Wang et al., 2021). These findings underscore the importance of integrating green infrastructure into urban

planning to create healthier living environments that address overcrowding, noise, pollution, and safety concerns.

The residential environment operates as both a direct and indirect mediator of the relationship between environmental greenery and mental wellbeing. Directly, it influences daily opportunities for restorative experiences. Indirectly, it interacts with social, economic, and environmental variables that shape how green spaces are used and valued.

2.10.7 Time spent in Green Space

While proximity to green space is a critical determinant of potential exposure, the actual time spent in these environments is a more direct indicator of realised exposure and is increasingly recognised as an important mediator in the relationship between environmental greenery and mental wellbeing. Van den Berg et al. (2017) found that even when no overall association existed between the level of greenness in the immediate environment and mental health, the frequency and duration of visits to nearby green spaces were significantly associated with better mental health outcomes. This suggests that simply living near green space does not guarantee psychological benefits, but active engagement is key.

Empirical evidence supports the idea that dose-response relationships exist between time spent in nature and improvements in mental wellbeing. For example, White et al. (2019) analysed a large UK sample and found that individuals who spent at least 120 minutes per week in natural environments reported significantly higher levels of health and wellbeing compared to those with less exposure. This effect was consistent across age groups, genders, and socioeconomic strata, indicating broad applicability. Similarly, Pasanen et al. (2018) observed that more frequent visits to natural settings were associated with greater life

satisfaction and fewer symptoms of depression, independent of total green space availability in the neighbourhood.

The quality and type of activities undertaken during visits also influence the benefits. Active forms of engagement, such as walking, cycling, or gardening, have been linked to greater reductions in stress and improvements in mood compared to passive activities like sitting or simply passing through green areas (Twohig-Bennett & Jones, 2018). However, even passive exposure can offer restorative benefits, particularly for individuals with mobility constraints or high baseline stress levels (Barton & Pretty, 2010).

Cultural and contextual factors can also shape patterns of time spent in green space. In studies from East Asia, including Yue et al. (2022), older adults often used local parks for low-intensity physical activities such as group exercise, which foster both physical health and social connectedness. In European contexts, daily commuting routes that pass through green corridors have been shown to contribute to mental wellbeing through incidental exposure, even if recreational use is limited (Mitchell, 2013).

Importantly, barriers such as safety concerns, poor maintenance, weather conditions, and limited mobility can constrain the amount of time people spend outdoors, especially among vulnerable groups (McCormack et al., 2010). Addressing these barriers, through improved park infrastructure and environmental maintenance, can increase engagement and help residents achieve beneficial doses of nature and greenery.

The evidence therefore underscores that time spent around environmental greenery functions as both a behavioural mediator and a practical measure of nature contact, bridging the gap between availability and health outcomes. Public health and urban planning initiatives should not only aim to increase the quantity of environmental greenery but also to promote

and facilitate its use, ensuring equitable access to opportunities for sustained, high-quality engagement with nature.

2.11 Evidence from the Maltese Landscape

Following the broader international evidence explored in the preceding sections, it is equally critical to consider context-specific research that reflects the unique socio-environmental dynamics of small island states. Malta, one of the most densely populated countries in Europe with limited green infrastructure, offers a distinctive case for examining how environmental greenness influences mental wellbeing. Despite spatial constraints and urban pressures, studies carried out in Malta have documented significant psychological and social benefits from nature exposure.

Desira (2014) investigated the concept of biophilia and nature connectedness among adults in Malta and Gozo, focusing on how childhood experiences influenced emotional and psychological attachment to nature in later life. The study found that individuals who engaged in outdoor activities such as countryside walks or tree planting during childhood scored significantly higher on the Connectedness to Nature Scale (Mayer & Frantz, 2004) in adulthood. These findings suggest that early nature engagement can serve as a long-term determinant of environmental attitudes and mental wellbeing.

Similarly, Camilleri (2023) conducted a quantitative study using the Body Image in Nature Survey (BINS) framework, revealing that nature exposure in Malta is significantly correlated with self-reported measures of life satisfaction, body appreciation, and self-compassion. Importantly, frequent interaction with natural spaces, particularly green coastal areas, was associated with lower stress and anxiety levels. The findings reinforce international models

that propose affective and cognitive restoration as key pathways linking nature exposure to mental health.

Borg (2022) explored different modes of nature engagement among Maltese adults, namely intentional, incidental, and indirect. Although only 25% of respondents reported regular intentional engagement with nature, all forms of interaction were positively associated with perceived mental health benefits, such as mood improvement and stress reduction. The study also highlighted significant disparities in access to and use of green space between urban and rural residents, underscoring the role of geographical and infrastructural factors.

Abela (2008), writing from an agricultural and urban ecology perspective, analysed the aesthetic, functional, and psychological importance of urban greenery among students at the University of Malta. Findings revealed strong support for the idea that trees and small-scale green installations provide opportunities for informal social interaction, passive recreation, and psychological relief, particularly in dense academic and urban environments. Greenery was also viewed as a critical buffer against traffic, stress and visual fatigue.

Briguglio (2021) provided a reflective socio-ecological commentary on the human-nature relationship in Malta, warning that continued environmental degradation and loss of biodiversity could jeopardize not only ecological sustainability but also the mental wellbeing of the population. The work underscores the concept of nature as a life-support system, not just for physical survival but for emotional and cognitive resilience, particularly in the context of climate vulnerability and environmental decline.

Taken together, the Maltese literature offers valuable contributions to the growing body of research on the relationship between environmental greenery and mental wellbeing. These studies span various themes; from childhood nature connectedness and urban greenery

perceptions to Covid-19 pandemic-era nature appreciation and socio-environmental commentary. Employing both qualitative and quantitative methodologies, the research reflects the unique socio-ecological conditions of the Maltese Islands, highlighting local attitudes, experiences, and barriers related to nature exposure. Collectively, this body of work provides important context-specific insights that complement international findings and inform future research and policy development within small island states.

2.12 Synthesis of findings from the Literature Review

The synthesis of evidence from the 25 included studies reveals a generally consistent, though nuanced, positive association between environmental greenery and adult mental wellbeing across diverse geographic, cultural, and socio-economic contexts. Regardless of whether studies were conducted in high- or low-density urban areas, and across both high- and low-income settings, greener environments were typically associated with reduced psychological distress, improved mood, and higher life satisfaction (Wang et al., 2021; Yue et al., 2022). The relationship was evident in both cross-sectional and longitudinal designs, though variations in effect size, statistical significance, and identified pathways were influenced by measurement approaches, population characteristics, and contextual factors.

Objectively measured environmental greenery, commonly quantified via the NDVI at buffer distances varying between 100 m and 3 km, was frequently linked with better mental health outcomes. For example, Astell-Burt et al. (2013) found that adults in the highest tertile of green space coverage had 33% lower odds of psychological distress compared to those in the lowest tertile, controlling for demographic and lifestyle covariates. Dadvand et al. (2016) similarly observed that a one interquartile range increase in NDVI within 500 m of the home was associated with a 4.2% reduction in the odds of depression across multiple European cities.

However, some studies, such as van den Berg et al. (2017), reported no significant associations unless time spent in green spaces was considered, suggesting that static exposure metrics may overestimate benefits in the absence of behavioural engagement data.

Some studies adopted the use of subjective perceptions of environmental greenery. These often exhibited strong associations with mental wellbeing. Pasanen et al. (2023) found that self-rated quality and accessibility of local green areas were more predictive of WHO-5 wellbeing scores than NDVI-derived greenness. In a similar approach, Liu et al. (2019) showed that perceived greenness mediated the relationship between objective vegetation coverage and life satisfaction among older adults in Guangzhou, with perceived quality accounting for up to 42% of the variance in wellbeing outcomes. This is echoed in the Maltese context, where Camilleri (2023) found that self-reported wellbeing, body appreciation, and stress reduction were significantly associated with frequent exposure to natural areas, particularly green coastal environmentsThis supports the emphasis on perceived quality and emotional connectedness to nature. These findings emphasise that the mere presence of environmental greenery is insufficient; factors such as safety, maintenance, biodiversity, and recreational suitability determine whether green spaces are used and confer psychological benefits (Kruize et al., 2020).

Several interacting mechanisms underpin the observed associations. Restorative experiences facilitated by natural environments align with the principles of ART (Kaplan, 1995) and Stress Reduction Theory (Ulrich, 1984), both of which were empirically supported across the reviewed studies (Kruize et al., 2020; Pasanen et al., 2023). Desira (2014) adds further evidence from Malta, demonstrating that childhood exposure to nature, such as through tree planting and countryside walks, enhanced adult emotional attachment to natural

environments, aligning with the biophilic theory and underscoring the long-term psychological value of early-life nature engagement.

Environmental greenery function as social venues, fostering trust, informal interaction, and collective efficacy. Studies such as Qin et al. (2021) and Wang et al. (2021) demonstrated that social cohesion mediated the greennery–mental wellbeing relationship, buffering against isolation and loneliness. Findings by Abela (2008) similarly highlight how even small-scale green installations within Maltese urban environments foster informal social interaction and psychological relief, especially in high-density settings such as university campuses.

Green environments encourage physical activity, which in turn predicts improved mental wellbeing. Astell-Burt et al. (2013) observed that environmental greenery was particularly protective for individuals meeting physical activity guidelines, indicating a possible interaction effect between environmental greenery exposure and behavioural engagement. Additionally, vegetation mitigates environmental stressors, including air and noise pollution, excess heat, and urban crowding, thereby reducing cumulative stress burdens, with especially marked benefits for older adults and those with chronic illnesses (Dzhambov & Dimitrova, 2014; Bakhtsiyarava et al., 2024).

Despite the overall consistency of findings, several contradictions and context dependencies emerged. For instance, Fisher et al. (2022) identified tree canopy coverage above 30% as particularly protective against distress, whereas Akpinar (2016) reported positive associations with total environmental greenery regardless of vegetation type, suggesting possible differences in benefit by the type of vegetation. Similarly, van den Berg et al. (2010) found that green proximity buffered the mental health impact of stressful life events in rural and suburban settings but not in dense urban cores, highlighting the importance of

environmental context. Huang et al. (2022) further demonstrated that street-level greenery predicted mental wellbeing independently of NDVI, implying that fine-scale vegetation features may be underestimated by coarse remote sensing indices. In Malta, a small island country where urban green cover may be limited due to geographic constraints, studies by Borg (2022) show that even incidental and indirect forms of engagement with nature, such as visual access to environmental greenery or proximity to natural landscapes, can contribute positively to mental wellbeing. Such findings suggest that in spatially constrained environments, the threshold for beneficial green exposure may differ from more vegetation-rich regions.

Socio-demographic and cultural moderators were also apparent. Callaghan et al. (2021) reported stronger environmental greenery–mental wellbeing associations in outer London compared to inner-city boroughs, potentially reflecting differences in environmental quality, density, and access. McEachan et al. (2018) observed that access to green space was linked to fewer behavioural difficulties among South Asian children but not White British children in similar socio-economic contexts, suggesting that cultural norms and social use patterns influence the translation of exposure into mental health benefits. Chinese studies (Liu et al., 2019; Yue et al., 2022) often integrated neighbourhood satisfaction and perceived social harmony into mental wellbeing metrics, contrasting with European studies' greater emphasis on distress reduction and life satisfaction indices such as the GHQ-12 and SWLS. Briguglio (2021), writing from a Maltese socio-ecological perspective, reinforced the idea that loss of biodiversity and degradation of the natural environment are perceived not only as ecological threats but also as risks to collective psychological resilience, particularly within vulnerable small island communities. This cultural sensitivity to nature's symbolic and existential value

adds an important layer to understanding mental wellbeing outcomes in underrepresented contexts.

Methodological heterogeneity remains a barrier to direct comparison. The reviewed studies employed a wide range of environmental greenery exposure metrics (NDVI, land-use classifications, street-level greenness, canopy cover) and outcome measures (GHQ-12, WHO-5, CES-D, SWLS), which complicates synthesis and meta-analysis. While objective measures provide robust ecological data, they may fail to capture lived experiences. Conversely, subjective measures, though more reflective of user experience, are vulnerable to reporting biases. Integrating both approaches, alongside longitudinal and quasi-experimental designs, would strengthen causal inference and improve generalisability. The Maltese studies collectively demonstrate the value of mixed-method approaches, combining psychometric tools with narrative insights and reflective commentary, to better understand how lived experience and place attachment mediate the relationship between environmental greenery and mental wellbeing (Desira, 2014; Briguglio, 2021; Camilleri, 2023).

In conclusion, international and local evidence indicates that environmental greenery benefits mental wellbeing through intertwined psychological, behavioural, and environmental pathways. These benefits are moderated by socio-demographic, cultural, and environmental factors. Accessibility, usability, and perceived quality are as critical as quantity in determining mental wellbeing outcomes. The Maltese literature reinforces the importance of early-life nature experiences, socio-cultural attitudes, and geographic limitations in shaping engagement with nature and its psychological outcomes. These insights highlight the need for place-sensitive and equity-focused urban greening policies that address disparities in access

and integrate both objective and subjective indicators to maximise mental health benefits across diverse populations.

2.13 Research Gaps

Although there is strong evidence linking environmental green cover with improved mental wellbeing, several important gaps remain in the literature. A major challenge arises from methodological heterogeneity and measurement limitations. Many studies rely exclusively on objective indices such as the NDVI, which captures vegetation density but does not account for perceptions of accessibility, quality, or usability (Liu et al., 2019; Bakhtsiyarava et al., 2024). Other studies focused solely on subjective measures such as perceived greenery or satisfaction, which better reflect experiential aspects of green space but introduce potential biases related to recall and self-reporting (Yue et al., 2022; Pasanen et al., 2023;). Similarly, mental wellbeing outcomes are measured using a wide variety of tools, from general life satisfaction indices to clinical measures of psychological distress, making cross-study comparisons difficult. Few studies have adopted a triangulated approach that integrates both objective and subjective measures, a strategy that would allow for a more holistic understanding of how lived experiences of green space relate to quantifiable environmental data (Kruize et al., 2020).

Another prominent gap is the lack of longitudinal and experimental research. Most of the included studies are cross-sectional, which limits the ability to establish causality. While associations between exposure to environmental greenery and mental wellbeing are consistent, longitudinal designs are necessary to confirm temporal relationships and to examine how changes in green space availability, such as those resulting from urban greening interventions, impact mental health over time (Kondo et al., 2018; Callaghan et al., 2021).

Experimental research, including natural experiments like greening vacant lots, remains limited and tends to be concentrated in high-income countries, leaving uncertainty about how such interventions may perform in other contexts.

Socio-demographic moderators such as age, gender and SES also remain underexplored. Vulnerable groups, including older adults, women, and low-income communities, often face greater barriers to accessing high-quality green spaces, yet few studies explicitly examine how these factors moderate the benefits of environmental greenery exposure (Wang et al., 2021; Yue et al., 2022). Understanding how interventions can be tailored to the needs of diverse populations is critical for reducing health inequities (Bakhtsiyarava et al., 2024).

Additionally, the quality and functionality of green spaces themselves are often insufficiently assessed. Although some research highlights the importance of biodiversity, safety, maintenance, and amenities (Mavoa et al., 2019; Kruize et al., 2020), these characteristics are rarely integrated into standard exposure metrics. Such features play a significant role in determining the frequency of use and the degree of mental wellbeing benefit derived from green spaces, yet they remain overlooked in many quantitative assessments.

The literature also exhibits a strong geographic and cultural bias, as most research has been conducted in urbanised settings in Europe, Australia, North America, and parts of East Asia. Low- and middle-income countries (LMICs), where urban ecologies, cultural norms, and socio-political contexts differ considerably, are underrepresented in the evidence base (Yue et al., 2022; Bakhtsiyarava et al., 2024). This limits the global generalisability of findings and hinders the development of culturally appropriate interventions.

Finally, while multiple pathways linking environmental greenery to mental wellbeing have been hypothesised, such as physical activity, social cohesion, mitigation of urban heat, and

reduction in pollution, few studies measured these mediators concurrently. As a result, it remains unclear which mechanisms are most influential and how they interact (Dadvand et al., 2016; Kruize et al., 2020). Similarly, factors related to housing and neighbourhood conditions, including overcrowding, noise pollution, neighbourhood crime and environmental hazards, are not consistently incorporated as potential confounders or moderators (Yue et al., 2022; Pasanen et al., 2023). Addressing these gaps will be crucial for advancing urban health research and ensuring that evidence-based strategies effectively integrate green infrastructure into policies designed to promote mental wellbeing.

Building upon the identified research gaps, this study seeks to strengthen the evidence base on the relationship between environmental greenery and mental wellbeing among adults. This is a topic that remains underexplored within the Maltese context. Through the utilisation of objective measures of environmental greenery, the study aims to develop a more comprehensive understanding of how exposure to environmental greenery influences mental wellbeing. Furthermore, the analysis will consider key confounding variables and mediators highlighted in the literature review, such as socio-demographic characteristics, housing conditions, and neighbourhood features. Overall, this comprehensive investigative approach will directly address methodological and contextual gaps highlighted in the literature review and will constitute the core analytical component of the thesis.

2022), reflecting cultural conceptualisations of mental wellbeing that emphasise collective harmony and place attachment.

A recurring methodological consideration was the timeframe of measurement. Cross-sectional designs often assessed current or recent mental wellbeing (e.g. Past two weeks), while longitudinal studies evaluated changes over extended periods, capturing both

immediate and sustained impacts of environmental greenery exposure. For example, Astell-Burt & Feng (2019) tracked wellbeing changes over several years, offering insights into the cumulative benefits of sustained exposure.

Lastly, the diversity in mental wellbeing outcome measures reflected both the conceptual breadth of mental wellbeing and the influence of cultural and policy contexts. For example, studies in China (Liu et al., 2019; Yue et al., 2022) often integrated social harmony and neighbourhood satisfaction as mental wellbeing indicators, whereas European studies (van den Berg et al., 2010; Kruize et al., 2020) emphasised psychological distress reduction and life satisfaction. This reflects the differing priorities in public health and urban planning frameworks across different continents and countries.

Chapter 3: Methodology

3.1 Study Design

This study adopted a cross-sectional quantitative design, aimed at exploring the relationship between environmental greenery and mental wellbeing among adults in Malta. A cross-sectional survey was selected due to its efficiency in collecting data at a single point in time, its cost-effectiveness, and its ability to identify potential associations across large population samples. However, a limitation of this design is its inability to establish causality, as temporal relationships between exposure and outcome cannot be confirmed.

The design is particularly appropriate for the exploratory nature of this research, which investigates an under-studied relationship within the local Maltese context, providing a foundation for more advanced longitudinal or experimental studies in the future.

3.2 Study Population

The target population comprised of adults aged 18 years and above, residing in Malta and Gozo. The aim was to capture a diverse demographic sample representing different regions, socioeconomic backgrounds, and exposure levels to green environments. Eligible participants were required to understand and respond to the questionnaire either in the Maltese or English Language.

3.3 Sampling Technique and Sample Size

A non-probability, convenience sampling strategy was employed. This technique allowed for rapid recruitment from a variety of settings to ensure feasibility in a relatively short data

collection period. However, the trade-off was reduced generalisability of findings, as the sample may not demographically fully represent the broader Maltese adult population.

The aim was to recruit a total of six hundred (600) participants, a sample size that balances statistical power with logistical feasibility. Participant recruitment was distributed across three recruitment streams:

1. Tertiary educational institution (University of Malta).
2. Workplace settings, including governmental health department, governmental education department, and private sectors.
3. Primary healthcare centres in Mosta, Floriana, Paola, and Victoria.

This multi-site recruitment approach increased the diversity and representativeness of the sample across urban, rural and regional contexts.

3.4 Data Collection Tools and Procedures

3.4.1 Mental Wellbeing

Mental wellbeing was measured using the WHO-5 Wellbeing Index (WHO-5), a validated and widely used screening tool. It consists of five items assessing positive mood and functioning over the previous 14 days. Responses are recorded on a 6-point Likert scale (0 = "At no time" to 5 = "All of the time"), yielding a total score from 0 to 25, where higher scores indicate better mental wellbeing. These scores were then multiplied by four to acquire a score between 0 and 100.

The WHO-5 has demonstrated strong construct validity and cross-cultural reliability in multiple populations and settings (Allgaier et al., 2012; Christensen et al., 2015; Bonnin et al.,

2018; Perera et al., 2020), making it an appropriate choice for this study's aims and diverse participant base.

3.4.2 Objective Assessment of Environmental Greenery

Environmental greenery exposure was assessed using ArcGIS Pro software, which allows for high-resolution spatial analysis. For each participant, the centroid of their street of residence as well as the street of workplace was geocoded, and circular buffer zones of 300 m and 900m from these centroids were generated. These buffer zones represent approximately 5 and 15-minute walking distances, respectively, as recommended by the World Health Organization (WHO, 2016).

Within each buffer, the percentage of land covered by grassland, tree canopy, and cropland was calculated using publicly available national land-use databases. These layers allow the study to quantify different types of environmental greenery and evaluate their potential unique contributions to mental wellbeing.

3.5 Questionnaire Design

The structured questionnaire used in this study was developed to capture a comprehensive set of variables aligned with the study's objectives. It was distributed electronically using Microsoft Forms across all recruitment streams. Recognising accessibility needs, a paper-based version was also made available at health centres for participants who preferred completing the survey in a non-digital format, an attempt to mitigate the digital divide.

The questionnaire consisted of several key components. Demographic information was collected, including age, gender, and highest level of educational attainment. Geographical data was gathered through the self-reported street and locality of residence, and where

applicable, participants were asked to provide details of their workplace or educational institution. These geographic inputs were later used for geospatial analysis of environmental greenery exposure. Mental wellbeing was assessed using the WHO-5, and additional sections explored potential confounding factors such as social cohesion and levels of physical activity. The entire questionnaire was made available in both Maltese and English to maximise inclusivity and accommodate linguistic diversity within the population.

3.6 Data Collection Timeline and Ethical Considerations

Data collection was conducted over a one-month period, in August 2025. Ethical approval was obtained in advance from all relevant institutional and organisational bodies involved in participant recruitment. Participants were provided with detailed information about the purpose and procedures of the study.

Participation in the study was entirely voluntary and anonymous. Respondents were informed of their right to withdraw from the study at any time, without the need to provide a reason and without any consequence. In terms of data protection, the study fully adhered to the General Data Protection Regulation (GDPR). All digital records were stored on password-protected systems, and no personal identifying information was retained at any stage of the research process.

3.7 Data Analysis Plan

The analysis of the data involved both descriptive and inferential statistical approaches. Descriptive statistics were used to summarise key demographic characteristics such as age, gender distribution, and levels of educational attainment, as well as environmental variables including environmental greenery exposure and WHO-5 scores.

Inferential statistics were employed to examine the relationships between variables. Correlational analyses, using Pearson or Spearman coefficients depending on normality assumptions, were used to assess the strength and direction of associations between environmental greenery and mental wellbeing. Additionally, multivariable regression models were utilised to examine these relationships while adjusting for potential confounding variables, including age, socioeconomic status, physical activity, and social cohesion. The analysis was all carried out using SPSS version 30.0.0.

3.7 Strengths and Limitations

This study presented several methodological strengths. The use of objective, high-resolution geospatial data for measuring environmental greenery exposure provides a reliable and precise approach that surpasses self-reported environmental data. The WHO-5, a globally validated psychological instrument, was employed to ensure robust measurement of mental wellbeing across diverse population subgroups. The inclusion of multiple recruitment sites, including educational institutions, workplaces, and community healthcare settings, enhanced the diversity of the sample. Furthermore, the application of ArcGIS tools enabled the study to introduce an innovative and replicable methodology suited to Malta's compact geography.

Nonetheless, the study also had notable limitations. The cross-sectional nature of the research limits the ability to establish causal relationships between environmental greenery exposure and mental wellbeing, as temporal sequences cannot be inferred. The use of convenience sampling introduces the possibility of selection bias, which may reduce the generalisability of the findings to the broader Maltese population. Additionally, the reliance on self-reported data introduces the risk of recall and social desirability biases, particularly in subjective mental wellbeing assessments. Moreover, while efforts were made to include

participants from varied backgrounds, the digital format of the questionnaire may have excluded individuals with limited digital literacy or access, thereby potentially skewing the sample composition.

3.8 Reproducibility

The research methods used in this study were designed with transparency and replicability in mind. The geospatial analysis, including the delineation of 300m and 900m buffer zones and the calculation of environmental green cover percentages using ArcGIS Pro, followed a standardised approach based on existing literature. The wellbeing assessment tool (WHO-5) is publicly available and widely validated, making its application easily transferable to other studies and contexts. Additionally, all procedures related to participant recruitment, questionnaire design, and data processing have been carefully documented. These elements together ensure that the study could be reproduced by other researchers in similar urban or small-island settings, contributing to the broader evidence base on the relationship between environmental greenery exposure and mental wellbeing.

Chapter 4: Results

4.1 Overview of dataset

A total of 691 participants were included in the analyses. All correlation analyses were performed using Spearman's test. The main outcome variable was the WHO-5 Wellbeing Index Scores. Exposures of interest were measures of environmental greenery in terms of grassland, tree canopy, and cropland, within 300m and 900m buffers from the centroid of the street of residence and street of workplace or educational institution.

4.2 Demographics

Out of the 691 participants, 690 identified as male or female, while one participant reported their gender as 'Other.' The sample was predominantly female (77.1%, n = 532), with male participants representing 22.9% (n = 158). The predominance of the female gender was observed consistently across all age and education categories.

The age distribution showed good representation across adult age groups, though with some clustering in the middle age group. The largest age cohort was 45–54 years (29.7%, n = 205), followed by 35–44 years (24.5%, n = 169) and 25–34 years (18.1%, n = 125). Relatively smaller proportions were observed among participants aged 55–64 years (16.2%, n = 112), 18–24 years (6.2%, n = 43), and 65–74 years (5.2%, n = 36). Only one participant (0.1%) fell in the 75–84 age cohort. Across all age groups, the female gender was more prevalent, with the widest gender gap noted in the 35–44 and 45–54 age cohorts.

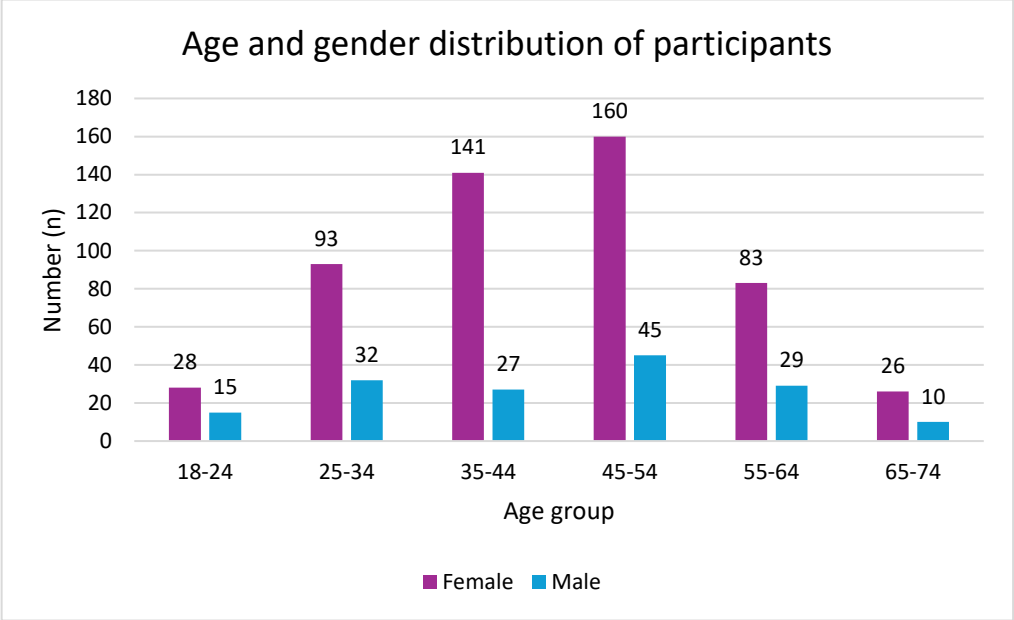

Figure 2: Age and gender distribution of participants

Given the low frequency of responses within the lower educational categories (ranging from primary to post-secondary levels), these were consolidated into a single category labelled 'Up to post-secondary' educational attainment. The remaining categories were retained as separate groups; University diploma or certificate, Bachelor's degree, and Postgraduate diploma or certificate. Due to the small number of participants with a Doctorate degree (n = 7), this category was combined with Master's degree to form the group Master's/Doctorate degree. This grouping was carried out to facilitate clearer visual representation in the figure 3.

In terms of educational attainment, the sample was generally highly educated. When asked about the highest education level attained, 28% held a Master's degree (n = 200), while a further 28% had completed a Bachelor's degree (n = 194). Smaller proportions reported postgraduate diplomas or certificates (14.6%, n = 101), and university diplomas or certificates (9.4%, n = 65). Secondary/post-secondary education as the highest education level attained was reported by 16.9% (n = 117) while only a few participants had completed only primary

education (0.4%, n = 3). Additionally, six participants selected 'Other' as their highest level of education.

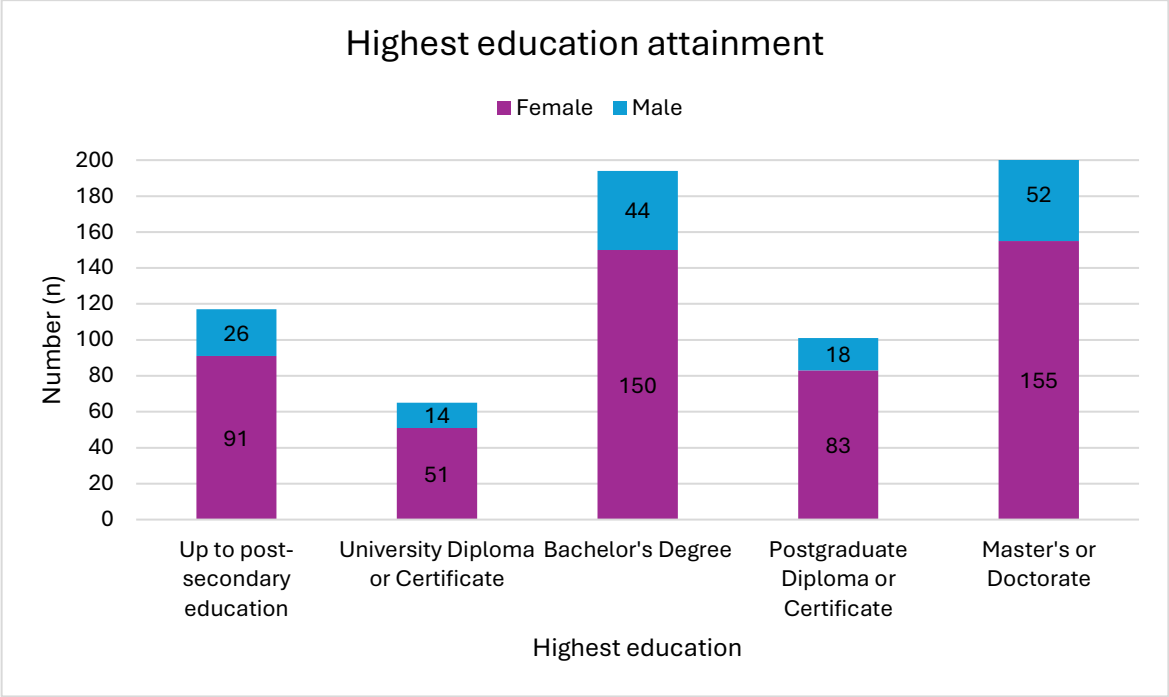

Figure 3: Highest Education Attainment among participants

4.3 Presence of Chronic Disease

Of the 691 participants, just under one-third (32.7%, n = 226) reported having at least one chronic illness. Chronic illness prevalence varied considerably by both age and sex.

Looking at the age distribution, the proportion reporting chronic illness increased steadily with age, reflecting the expected increased probability of having chronic health conditions with increasing age. Among the youngest participants aged 18–24 years, only 11.6% (n = 5) reported a chronic illness, while prevalence rose to 26.4% (n = 33) among those aged 25–34 years and 30.2% (n = 51) among those aged 35–44 years. The prevalence reached its peak in middle-aged and older adults, with 34.1% (n = 70) of participants aged 45–54 years, 42.9% (n = 48) of those aged 55–64 years, and 52.8% (n = 19) of those aged 65–74 years reporting a

chronic illness. The sole participant aged 75–84 years reported the presence of chronic illness. These findings highlight a clear gradient of rising chronic illness prevalence with age.

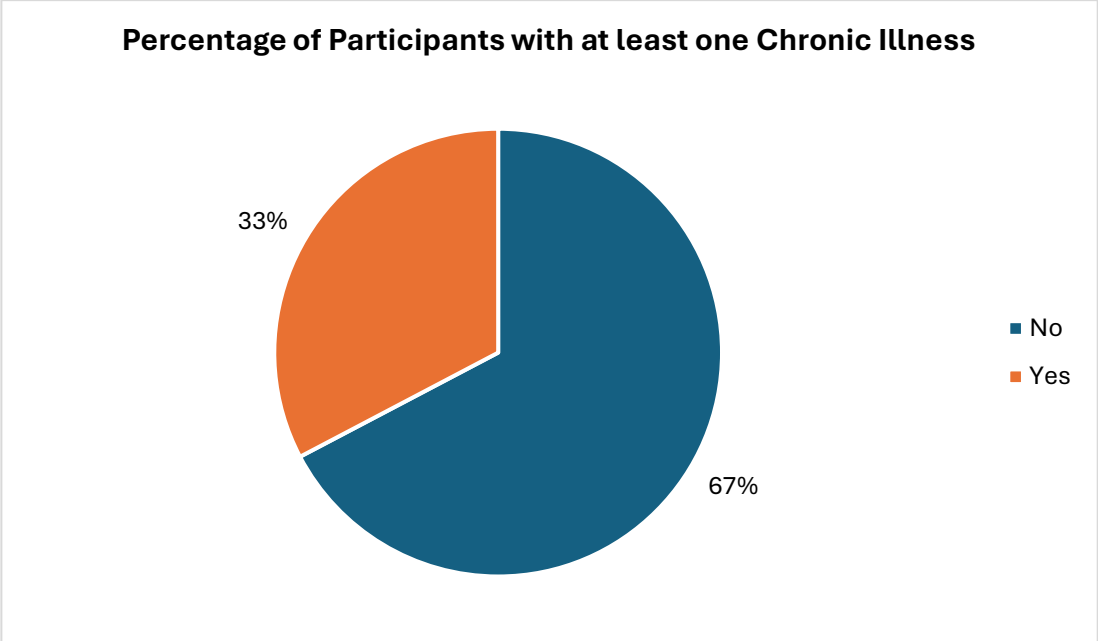

Figure 4: Percentage of participants reporting at least one chronic illness

As already described above, women had greater representation in the sample and therefore higher absolute numbers of reported chronic illness. Of the 532 female participants, 33.3% (n = 177) reported a chronic illness, compared with 30.4% (n = 48) of the 158 male participants. The overall burden of chronic illness was slightly more pronounced among women

These results therefore show that chronic illness was common in this study population, affecting nearly one in three participants, with prevalence rising steeply with increasing age and being slightly higher among women. This pattern is consistent with established evidence on the age- and sex-related distribution of chronic disease in a population (Jürisson et al., 2021).

4.4 Physical Activity and Sedentary Behaviour

Patterns of physical activity varied widely across participants, with marked differences observed by both age and gender.

4.4.1 Walking

Walking was common among participants, with the majority reported walking at least once per week, though frequency varied. Around one in eight participants (12.9%, n = 89) reported never walking for at least 10 minutes a day, while 18.7% (n = 129) reported walking for at least 10 minutes on all seven days of the week. Middle-aged adults (35–54 years) showed the highest frequencies of daily walking. Women generally reported walking more frequently than men.

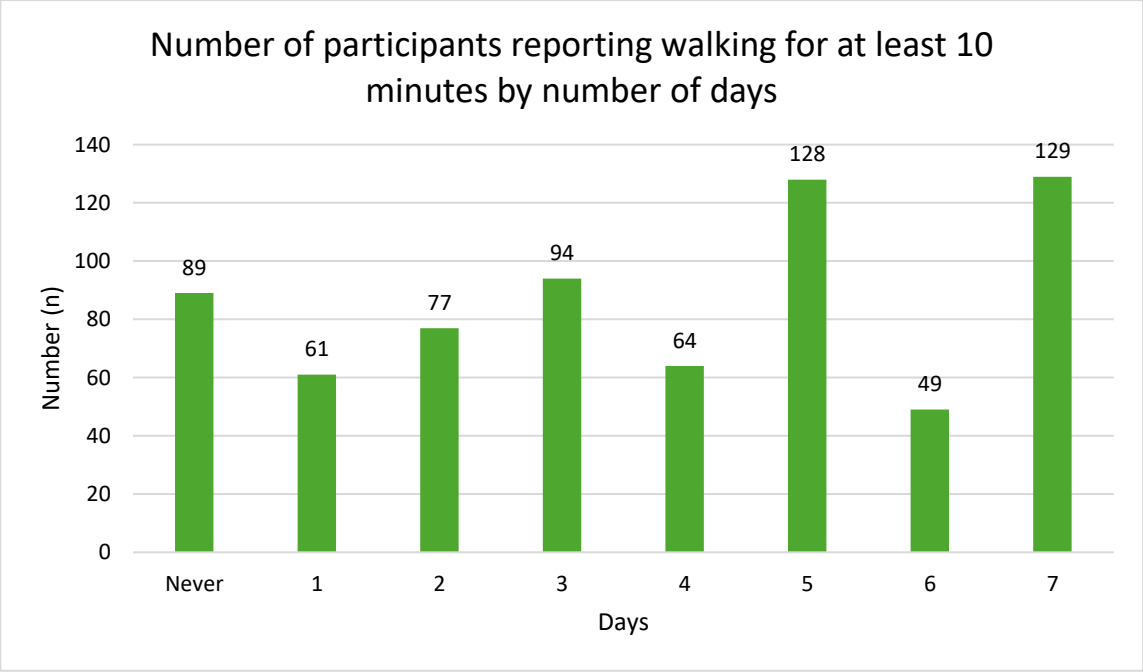

Figure 5: Number of participants reporting walking for at least 10 minutes by number of days

When asked about the duration of continuous walking bouts, the majority (87.7%, n = 358) reported engaging in 10–30 minutes of continuous walking per day. Only a small minority reported walking for an hour or longer, suggesting that walking in this study population was primarily for short distance commuting purposes.

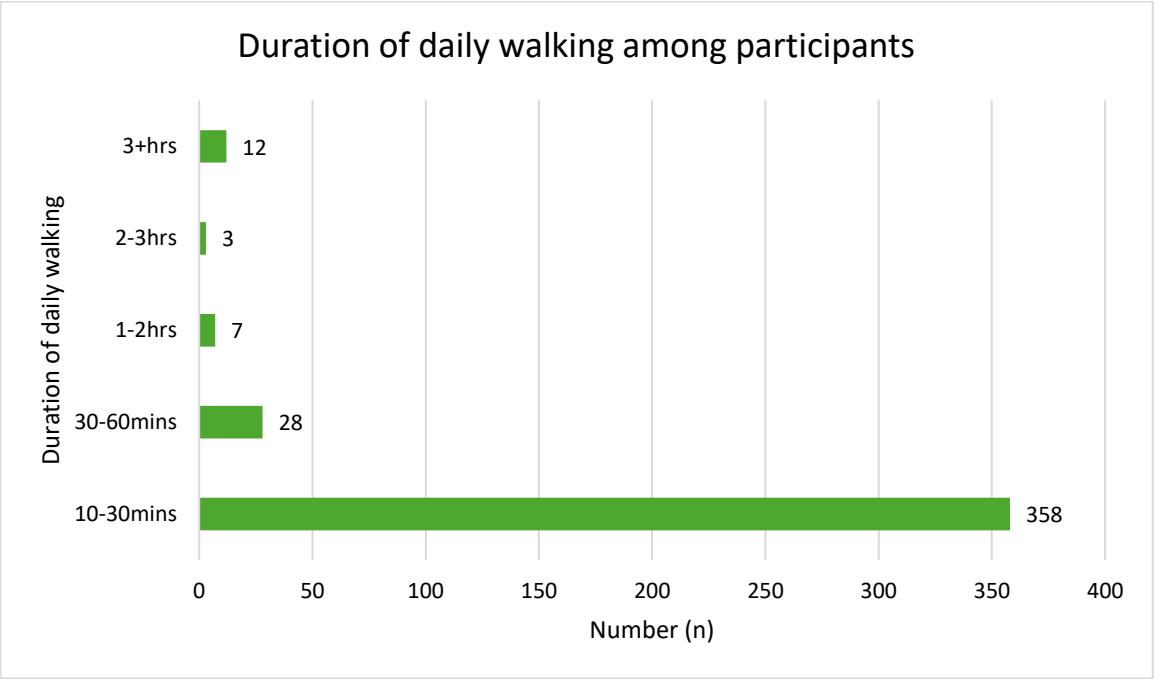

Figure 6: Duration of daily walking among participants who reported walking daily

4.4.2 Bicycle Use

Cycling activity was very uncommon as a mode of transport. More than nine out of ten participants (94.9%, n = 656) reported never cycling for at least 10 minutes in a week, and therefore very few engaged in regular cycling. Hence, reports of continuous cycling to get from one place to another were scarce among recruited participants. This suggests that cycling is a very unpopular form of transport in this sample.

4.4.3 Sports, Fitness or recreational physical activities

Engagement in sports activities showed more variation. Around one-third of participants (34.7%, n = 240) reported never engaging in sports for at least 10 minutes per week, while others reported regular participation, with smaller groups spread across frequencies of one to seven days per week. Men were proportionally more likely to report frequent engagement in sport than women.

Participation in vigorous physical activity was relatively lower with over half of the participants (53.0%, n = 366) reported never engaging in such activities, while only a small proportion (9.0%, n = 62) reported participation on five or more days per week. This indicates that physical activity of vigorous intensity was less common than moderate activity in the sample.

Muscle strengthening exercise prevalence followed a similar pattern to that of vigorous physical activity. More than half (55.4%, n = 382) reported never engaging in muscle strengthening exercise, while the remaining participants reported one to four days per week. A very small number (n = 21) reported frequent weightlifting (six or seven days per week). Men were more likely to engage in weightlifting than women, but overall prevalence was low.

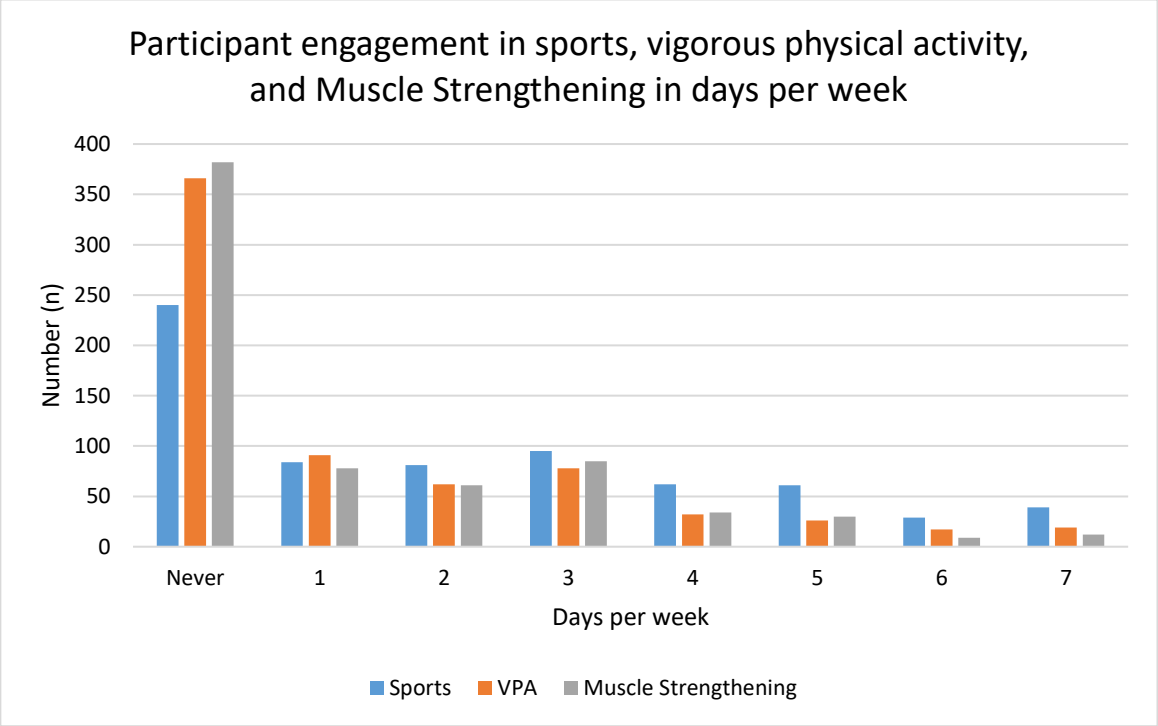

Figure 7: Participant engagement in sports, vigorous physical activity and Muscle Strengthening in days per week

4.4.5 Walking for leisure

Walking for leisure showed higher participation with respect to sports and fitness. 30.0% (n = 207) reported never walking for leisure, while the remaining 70% reported doing so across varying frequencies. Leisure walking appeared particularly common among women and middle-aged adults, while younger adults showed somewhat lower engagement.

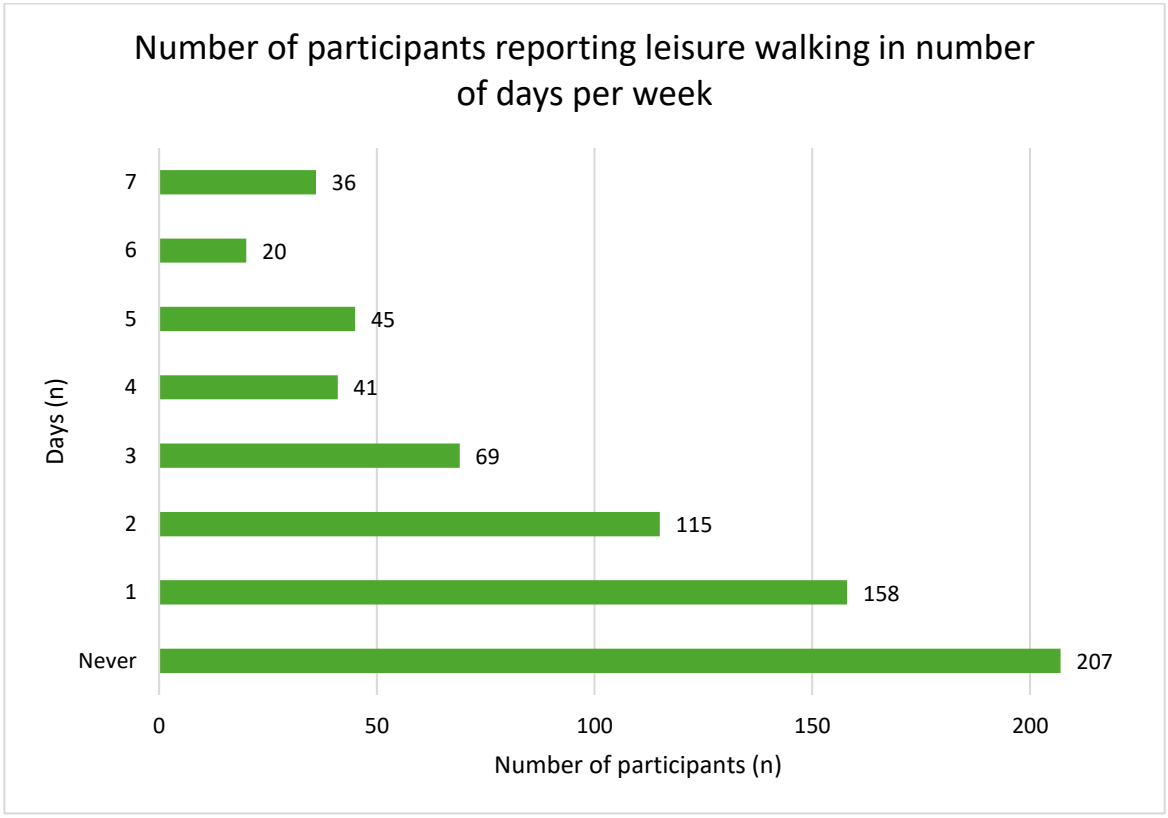

Figure 8: Number of participants reporting leisure walking in number of days per week

4.4.6 Sedentary Behaviour

Sedentary behaviour was widely reported with some variability between subgroups.

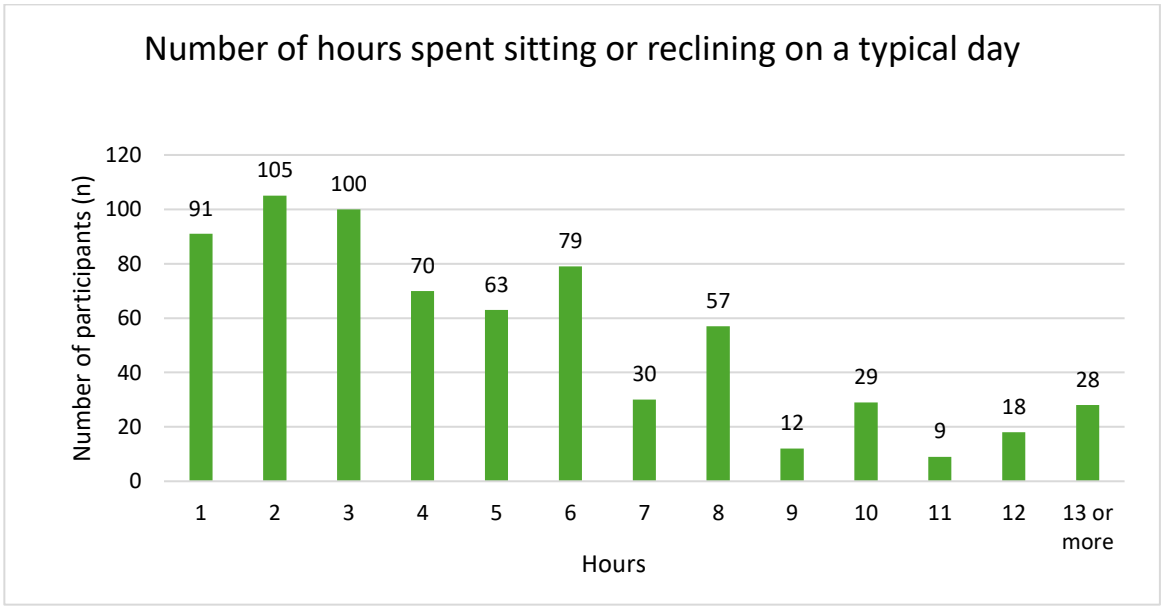

Figure 9: Reported number of hours spent sitting or reclining on a typical day

Overall, the findings on physical activity and sedentary behaviour suggest that in this study population, walking for transport and leisure were the most common forms of physical activity, while cycling, muscle-strengthening exercise, and vigorous physical activity were relatively uncommon.

4.5 Living conditions

Participants reported a range of housing and surrounding environmental exposures, with notable variation across both age and gender.

Household overcrowding was reported by 13.6% (n = 94) of participants, while the majority (86.4%) did not report overcrowded living conditions. Younger adults, particularly those aged 18–24 years (18.6%) and 35–44 years (14.8%), were more likely to report overcrowding with respect to older participants. Men were somewhat less likely than women to report overcrowding (10.8% vs. 14.3%).

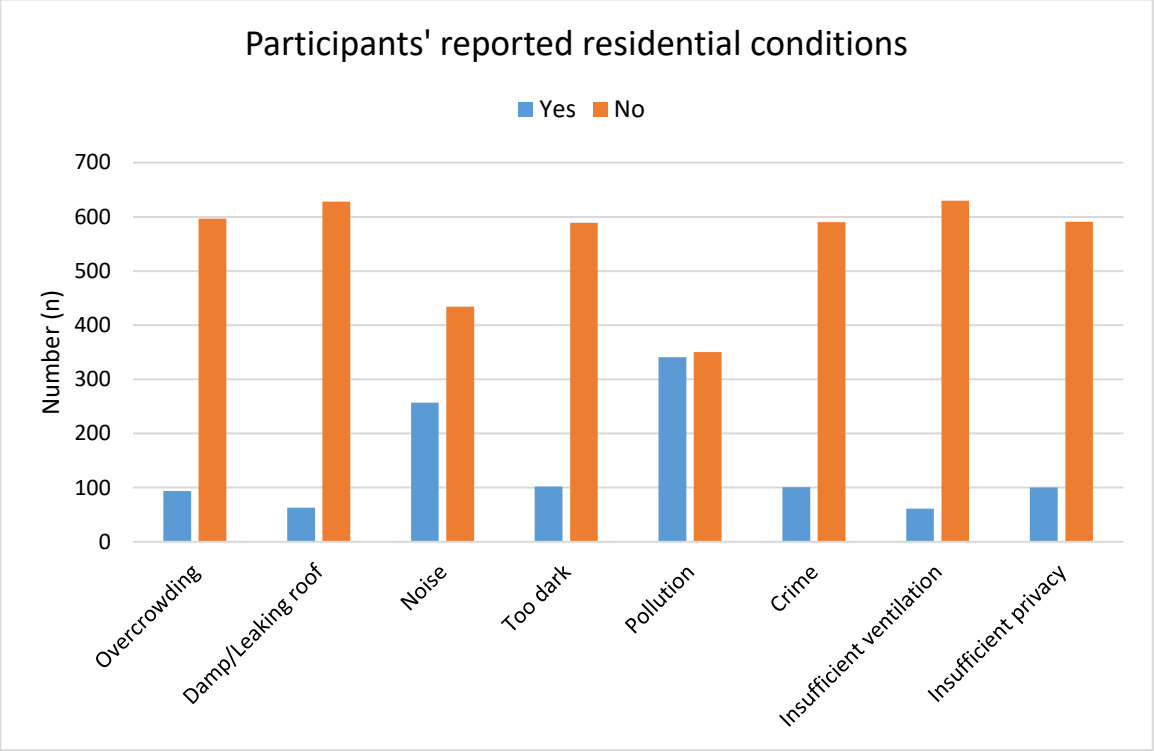

Figure 10: Reported residential conditions by participants

Structural problems, such as leaking roofs, damp, or rot, were reported in the positive by 9.1% (n = 63) of participants. These issues were slightly more common among younger and middle-aged adults (particularly those aged 35–44 years, 12.4%) than among older groups. Women and men reported similar prevalence, at 8.5% and 11.4% respectively.

Noise exposure was one of the most common problems identified. More than one-third of participants (37.2%, n = 257) reported noise from neighbours or outside the home. The prevalence was highest among those aged 25–54 years (ranging from 36–40%), and lowest among participants aged 65 years and older (13.9%). Women were somewhat more likely than men to report noise problems (38.0% vs. 34.2%).

Insufficient natural light, or darkness at home, was reported by 14.8% (n = 102). This problem was more frequent among adults aged 35–44 years (20.1%) and 65–74 years (33.3%). Women were more likely than men to report inadequate natural light (15.2% vs 14.7%).

Perceived pollution in the living environment was very common, affecting almost half of the sample (49.3%, n = 341). The prevalence increased steadily with age, from 41.9% among those aged 18–24 years to 52.2% among those aged 45–54 years, and 52.8% among those aged 65–74 years. Women were more likely than men to report pollution (50.2% vs. 46.2%).

Crime in the neighbourhood was reported by 14.6% (n = 101) of participants. This was most common among younger and middle-aged groups, particularly those aged 35–44 years (16.6%) and 45–54 years (13.7%). One participant aged 75–84 years also reported crime exposure. Women reported crime slightly more often than men (14.8% vs. 13.9%).

Poor ventilation was reported by 8.8% (n = 61) of participants, with prevalence higher among middle-aged adults (35–44 years at 12.4%) and somewhat lower among older groups. Women and men reported similar prevalence (8.5% vs. 10.1%).

Insufficient privacy at home was reported by 14.5% (n = 100). This problem was most frequently reported among participants aged 35–54 years (16.0–17.1%), while it was less common in older groups. Men were slightly more likely than women to report insufficient privacy (15.8% vs. 13.9%).

In summary, noise and perceived pollution were the most commonly reported living condition problems, affecting more than a third and nearly half of participants respectively. Overcrowding, inadequate natural light, crime, and lack of privacy affected about 15% of participants, while poor ventilation and structural issues were somewhat less common (<10%). These findings suggest that, although most participants did not report adverse housing conditions, a substantial minority experienced environmental stressors that may impact mental wellbeing, with noise and pollution particularly prevalent.

4.6 Social Cohesion

Indicators of social cohesion showed that most participants reported moderate to high levels of social connectedness and support, although a minority experienced limited ties or perceived low concern from others.

With respect to close personal relationships, the majority of participants reported having several people they could rely on. Over two-fifths (44.4%, n = 307) indicated that they had 3 to 5 close people, while almost one-quarter (23.6%, n = 163) reported six or more. Smaller groups reported only one or two close people (30.4%, n = 210), while a very small minority (1.6%, n = 11) reported having none. Age-stratified results suggested that younger adults (18–24 years) and middle-aged adults (35–54 years) were particularly likely to report higher numbers of close ties, while older adults (65+ years) more often reported only one or two close contacts. Women consistently reported having larger networks than men.

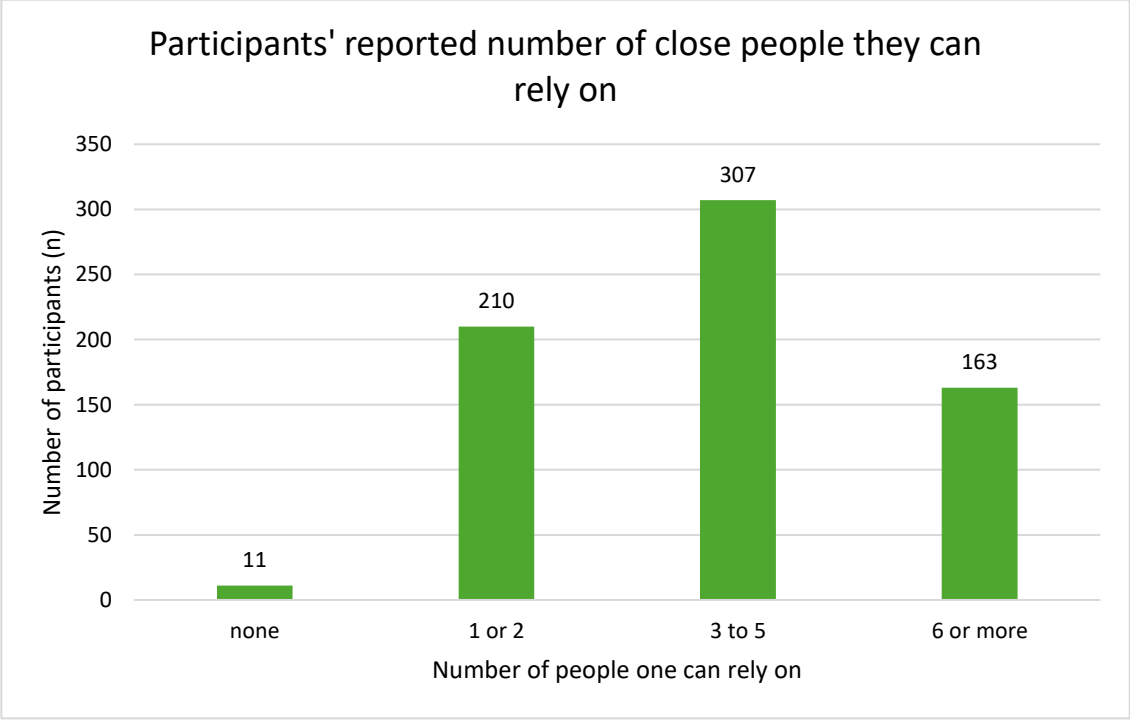

Figure 11: Participants' reported number of close people they can rely on

When asked about how much concern and interest they perceived from others, the largest proportion (50.4%, n = 348) reported ’some concern and interest‘, while a further 28.1% (n = 194) reported ’a lot of concern and interest‘. A smaller but meaningful group (12.7%, n = 88) responded ’not sure‘, reflecting uncertainty about the degree of care received from others. Only 8.2% (n = 57) perceived ’little concern and interest‘, and just 0.6% (n = 4) felt that they had no concern or interest from others. Reports of strong perceived concern were most common in younger and middle-aged adults, while older adults (65–74 years) were more likely to report little or no concern. Men were disproportionately represented among those reporting ’not sure‘ or ’little concern‘, whereas women more often endorsed higher levels of perceived support.

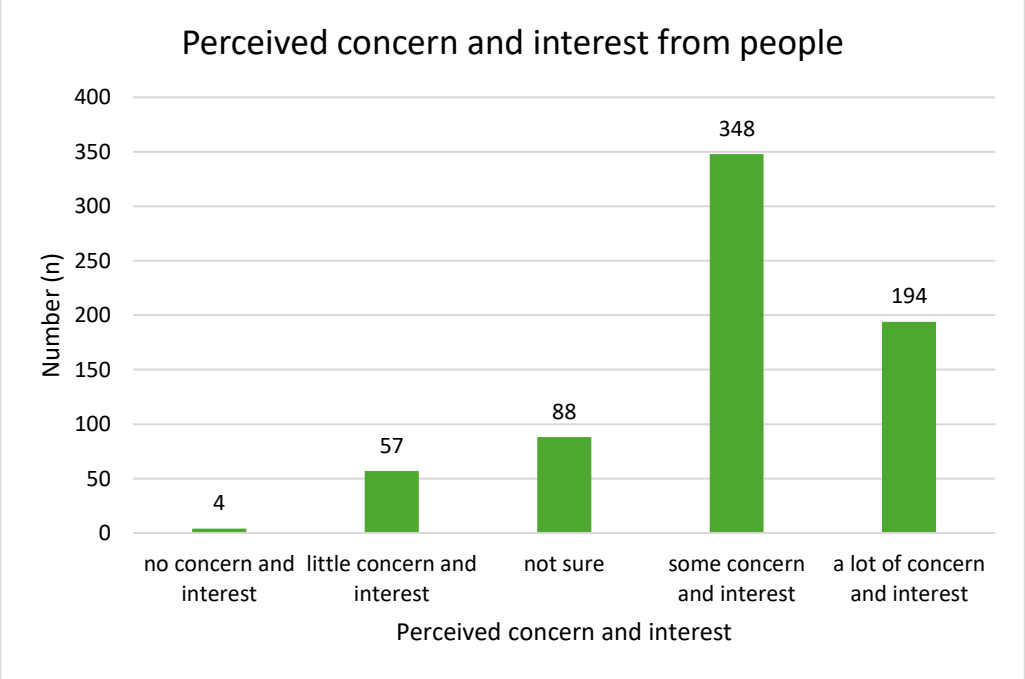

Figure 12: Participants' reported perceived concern and interest from people

Perceptions of neighbourhood support, that is, ease of obtaining help from neighbours showed greater variability. Roughly half of the participants reported that getting help was at least ’possible‘. Specifically, 45.0% (n = 311) rated neighbourly help as possible, 20.5% (n = 142)

said it was easy, and 7.5% (n = 52) described it as very easy. In contrast, more than one in four participants found this difficult; 16.5% (n = 114) rated it as difficult, and 10.4% (n = 72) as very difficult. Younger adults (18–24 years) were more likely to report difficulties in obtaining neighbourly help, whereas middle-aged adults (35–54 years) were more likely to view it as possible or easy. Women generally reported more favourable perceptions of neighbour support with respect to men.

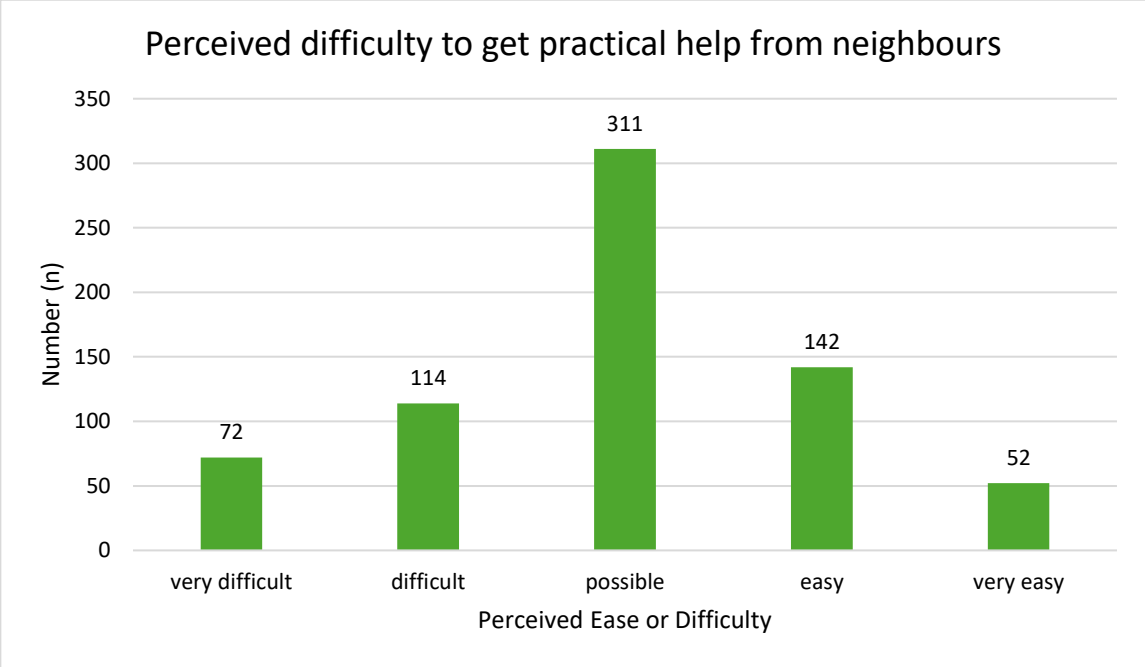

Figure 13: Reported perceived difficulty to get practical help from neighbours

Overall, these findings highlight that most participants had access to a supportive social environment, characterised by several close personal ties and moderate to high levels of perceived concern from others. However, a minority of participants reported either limited close contacts, uncertainty about the support they received, or difficulty accessing neighbourly help. Such disparities underline the heterogeneity of social cohesion within the sample, with potential implications for mental wellbeing.

4.7 Work description

Indicators of occupational activity showed that most participants reported jobs involving sedentary or standing work, with a smaller proportion engaged in moderate physical effort and very few in heavy labour. Only a minority reported not performing any tasks.

Almost two-thirds of participants (63.1%, n = 436) described their work as mostly sitting or standing, while nearly one-third (32.3%, n = 223) reported moderate physical effort such as walking or tasks requiring movement. Only 2.9% (n = 20) indicated that their work involved mostly heavy labour or physically demanding tasks, and 1.7% (n = 12) reported not performing any tasks.

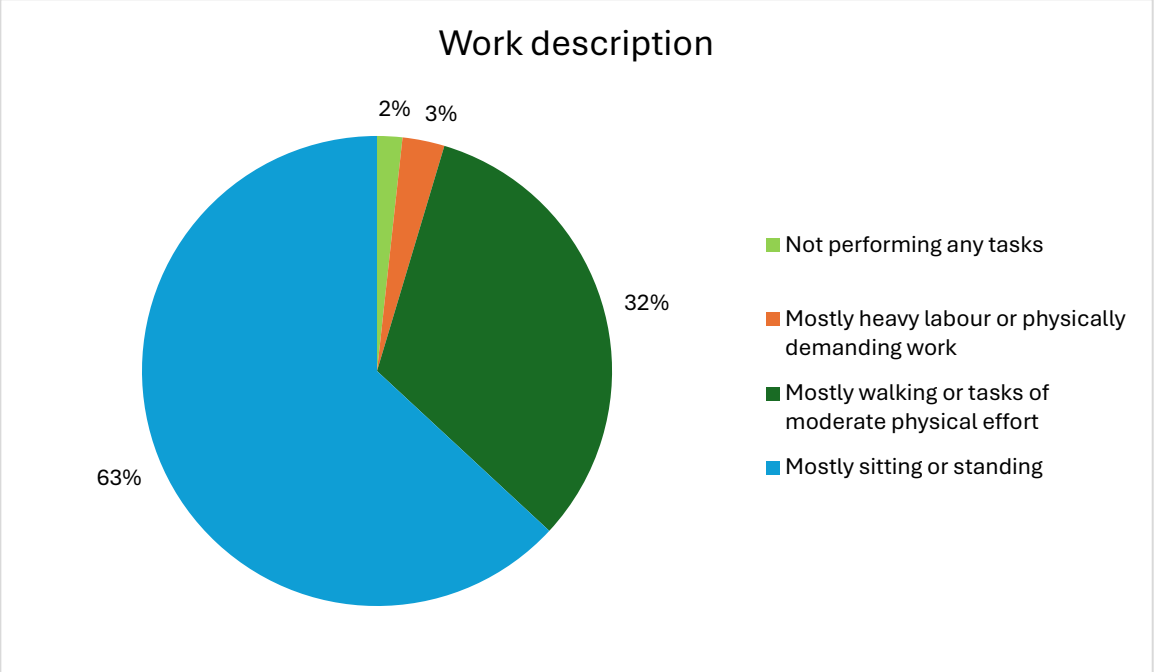

Figure 14: Reported occupational description in terms of labour

Age-stratified results showed that younger adults aged 18–44 years) were especially likely to report sedentary or moderate forms of work, with very few engaged in heavy labour. Among those aged 45–54 years, almost two-thirds reported sedentary jobs, while about one-third

performed moderately demanding tasks. In older adults (55–64 and 65–74 years), sedentary or standing jobs continued to predominate, though a slightly larger proportion reported moderate effort compared with younger groups.

When examined by gender, women most commonly reported sedentary or standing jobs (63.7%, n = 339), followed by moderate effort (31.6%, n = 168). A smaller proportion described heavy labour (3.2%, n = 17) or not performing tasks (1.5%, n = 8). Among men, sedentary or standing work was also the most frequent (60.8%, n = 96), though a relatively larger proportion reported moderate effort (34.8%, n = 55). Heavy labour was less common among men (1.9%, n = 3) compared to women.

These findings highlight that the majority of participants worked in roles characterised by prolonged sitting or standing, with a substantial proportion also engaged in moderately active work. Only a very small minority performed physically demanding labour or reported no tasks. These patterns suggest that, within this population sample, occupational activity is generally low-to-moderate in intensity, which may have implications for physical activity levels and related health outcomes.

4.8 WHO-5 Score

The WHO-5 Wellbeing Index scores ranged across the full scale, with participants represented from very low to very high scores, indicative of poor and strong mental wellbeing respectively. There was a mean score of 53.3 (SD±19.3). Minimum of 0 and maximum of 100 were registered.

When analysed by age group, patterns of mental wellbeing showed variation across the age groups. Among the youngest adults (18–24 years, n = 43), most respondents clustered in the

mid-to-high range, with relatively few reporting very low scores. Adults aged 25–34 years (n = 125) also showed predominantly mid-range to high mental wellbeing, with scores spread fairly evenly across these categories. The 35–44 years group (n = 169) demonstrated a wider spread, with a notable presence in both lower and higher score categories, reflecting more heterogeneity. The largest group, adults aged 45–54 years (n = 205), also displayed wide variability, though most respondents scored in the moderate to high range. For those aged 55–64 years (n = 112), mental wellbeing scores remained varied, but with somewhat more participants in the lower range with respect to younger age groups. Among older adults (65–74 years, n = 36), the distribution was more polarised, with some reporting low scores, below 36 with others maintaining moderate to high mental wellbeing scores.

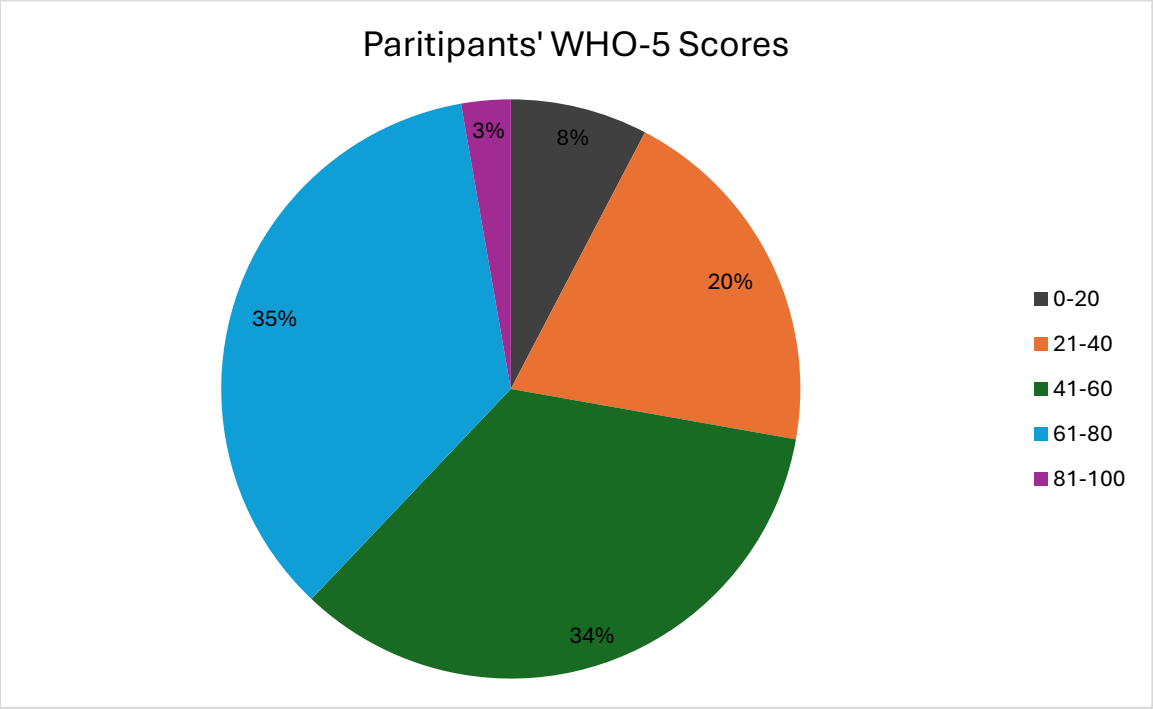

Figure 15: Reported WHO-5 Score among participants

When analysed by gender, both women and men were represented across the full spectrum of mental wellbeing scores. Among women (n = 532), the majority fell in the moderate to

higher score ranges, with clustering around 40–70 points, although some women did report very low scores (<20). Men (n = 158) showed a similar pattern but with a slightly greater spread into the lower categories; proportions of men with scores below 36 were modestly higher when compared to women. In both sexes, the number of participants with very high scores (>80) was small.

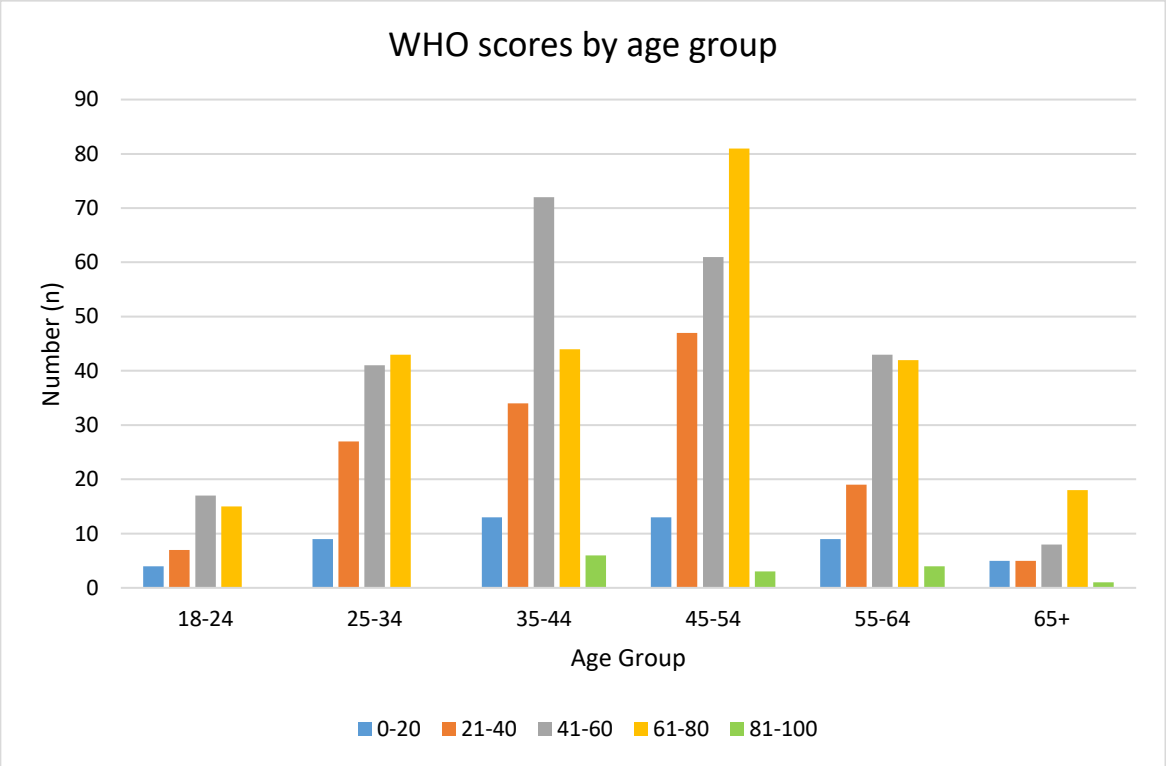

Figure 16: Reported WHO-5 Score by age group

Overall, WHO-5 score results indicate that most participants reported moderate to good mental wellbeing. Variability was most evident in middle-aged groups, where both low and high scores were common. Women and men demonstrated broadly similar distributions, though women's scores tended to cluster more in the mid-to-higher ranges, while men displayed slightly more dispersion towards lower scores.

4.9 Environmental Green Cover Results

Objective measures of environmental greenery were assessed within 300 m and 900 m buffers around each participant's residential location. Considerable variability was observed across the three categories of environmental greenery; grassland, tree canopy, and cropland.

Within the 300 m buffer, the mean proportion of grassland cover was 11.2% (SD±14.0), though this ranged widely from 0% to 84%, indicating that some participants had no nearby grassland, while others lived adjacent to extensive grassy areas. Tree canopy cover was comparatively low, with a mean of 4.0% (SD±5.6) and a maximum of 38%. Cropland cover averaged 7.2% (SD±10.4), ranging up to a maximum of 55%.

As expected, values were higher within the 900 m buffer, capturing a relatively broader geographical area. Mean grassland cover nearly doubled to 19.1% (SD±15.9), with a maximum of 80%. Tree canopy cover also increased modestly with a mean of 4.9% (SD±3.6) and a maximum of 22%. Cropland cover averaged at 12.4% (SD±10.5), reaching as high as 47%.

These results indicate that the study population lived in areas with relatively low average tree canopy cover, moderate levels of cropland, and variable access to grassland. The wider 900 m buffer consistently captured greater proportions of all environmental green cover types, reflecting more extensive landscapes surrounding residential neighbourhoods.

Both correlation and regression analyses were employed to examine the relationship between environmental greenery and mental wellbeing. The *p*-values obtained from these analyses, although related, serve distinct purposes. Correlation analyses using Spearman's ρ were conducted to assess the overall strength and direction of the bivariate association between environmental greenery indicators and WHO-5 mental wellbeing scores. The

corresponding *p*-values tested whether these associations were statistically different from zero, without accounting for other variables.

Regression analyses were then utilised to evaluate the independent effect of environmental greenery on mental wellbeing after adjusting for potential confounding factors, including demographic, social, health, behavioural, and environmental covariates. The *p*-values from regression therefore indicate whether a specific environmental greenery variable contributes significantly to predicting mental wellbeing, beyond the influence of other predictors in the model. This combined approach allowed for an initial exploration of simple relationships through correlation testing, followed by a more robust assessment of independent associations through multivariable regression models.

The results of the bivariate correlation analysis are summarised in table 5 below.

Table 5: Summary of statistical significance testing between environmental greenery and mental wellbeing

Environment	Greenery Indicator	Buffer (m)	Spearman's p-value	Sig.
Residential	**Grassland**	300	**0.040**	*
		900	0.067	ns
	Tree canopy	300	0.834	ns
		900	0.702	ns
	Cropland	300	0.197	ns
		900	0.384	ns

Environment	Greenery Indicator	Buffer (m)	Spearman's p-value	Sig.
	Total greenery	300	0.216	ns
		900	0.063	ns
Workplace	**Grassland**	300	0.138	ns
		900	**0.037**	*
	Tree canopy	300	0.428	ns
		900	0.233	ns
	Cropland	300	**0.045**	*
		900	**0.036**	*
	Total greenery	300	0.149	ns
		900	**0.023**	*

Notes:

- $p < 0.05$
- ** $p < 0.01$
- *** $p < 0.001$

4.10 Bivariate Correlation between Mental Wellbeing and Residential Environmental Green Cover

To explore whether exposure to environmental greenery around the residential environment was associated with mental wellbeing, correlations were computed between WHO-5 scores and objective environmental green cover indicators. Measures included the proportion of grassland, tree canopy, and cropland cover within 300 m and 900 m buffers of participants' residential streets. The normality of the WHO-5 mental wellbeing scores was assessed using the Shapiro–Wilk test, which indicated a significant deviation from normality ($p < 0.001$). Given this result, Spearman's correlation coefficient was used to examine the relationship between mental wellbeing and environmental greenery.

4.10.1 Residential Grassland Cover

Within the 300 m buffer, Spearman's rank-order correlation revealed a small but statistically significant positive association between grassland cover and WHO-5 wellbeing scores ($p = 0.040$). This suggests that individuals residing in areas with relatively greater grassland cover within their immediate surroundings tended to report higher levels of mental wellbeing. Although the effect size was small, the positive direction of the association indicates a potential link between nearby grassland cover and mental wellbeing outcomes.

At the 900 m buffer, a similar but slightly weaker pattern was observed. Spearman's correlation indicated a borderline positive association between grassland cover and wellbeing ($p = 0.067$). While this did not reach statistical significance, the trend nonetheless suggests that higher grassland cover in the broader residential environment may be associated with improved mental wellbeing.

4.10.2 Residential Tree Canopy Cover

Tree canopy cover within both buffer zones showed no meaningful association with mental wellbeing. At the 300 m buffer, Spearman's correlation indicated no relationship between tree canopy cover and WHO-5 scores (p = 0.834). Similarly, at the 900 m buffer, the correlation remained negligible (p = 0.702). These findings suggest that tree canopy cover, whether in the immediate or broader residential area, was not associated with mental wellbeing scores in this sample.

4.10.3 Residential Cropland Cover

Associations between cropland cover and mental wellbeing were weak and non-significant. At the 300 m buffer, Spearman's test indicated a small, non-significant positive relationship between cropland cover and WHO-5 wellbeing scores (p = 0.197). At the 900 m buffer, results were consistent, with a similarly weak and non-significant association (p = 0.384). These findings suggest that the amount of cropland surrounding residential areas did not demonstrate a meaningful relationship with mental wellbeing in this dataset.

4.10.4 Total residential environmental greenery

When the total percentage of environmental greenery (comprising of grassland, tree canopy, and cropland) within the residential buffers was considered as a composite indicator, correlations with mental wellbeing remained weak and non-significant. At the 300 m buffer, Spearman's correlation revealed a very small positive relationship between total greenery and WHO-5 scores (p = 0.216). At the 900 m buffer, the correlation was slightly higher but still weak and statistically non-significant (p = 0.063). These findings indicate that participants residing in areas with higher overall proportions of environmental green cover within both immediate (300 m) and extended (900 m) residential surroundings tended to report marginally higher

mental wellbeing scores, although these associations did not reach statistical significance. The consistently positive direction of the coefficients across both buffer distances suggests that total environmental greenery may exert a subtle but non-significant influence on mental wellbeing, reinforcing the pattern observed for grassland cover. Nonetheless, the effect sizes were minimal, indicating that total environmental greenery around residential areas accounted for only a very small proportion of the variance in WHO-5 scores.

4.11 Bivariate Correlation between Mental Wellbeing and Workplace Environmental Green Cover

In addition to residential environmental greenery, analyses were conducted to examine whether objective environmental greenery in the vicinity of participants' workplaces was associated with mental wellbeing. Environmental greenery indicators were also calculated within 300 m and 900 m buffers around each workplace street centroid, and included proportions of grassland, tree canopy cover, and cropland cover. As with residential greenery, Spearman's correlations were used.

4.11.1 Grassland Cover

At the 300 m buffer, Spearman's correlation indicated a weak and non-significant positive association between workplace grassland cover and mental wellbeing (p = 0.138). This suggests that immediate workplace surroundings with higher proportions of grassland were not meaningfully associated with WHO-5 scores.

At the 900 m buffer, the correlation was slightly stronger and reached statistical significance (p = 0.037). Although the strength of this association remained small, the finding indicates that

greater percentage of grassland cover within a broader 900 m buffer around the workplace may be linked to marginally higher levels of mental wellbeing.

4.11.2 Tree Canopy Cover

For tree canopy cover within 300 m of the workplace, Spearman's correlation indicated a very weak and non-significant positive association with mental wellbeing (p = 0.428). At the 900 m buffer, the relationship remained weak and non-significant (p = 0.233). Taken together, these results indicate that tree canopy cover surrounding workplaces was not meaningfully associated with WHO-5 scores in this sample.

4.11.3 Cropland Cover

Cropland cover in the workplace environment demonstrated more consistent associations with mental wellbeing. Within the 300 m buffer, Spearman's correlation indicated a weak but statistically significant positive relationship between cropland cover and WHO-5 scores (p = 0.045).

At the 900 m buffer, the association remained positive and statistically significant (p = 0.036). These findings suggest that higher levels of cropland cover within both the immediate and wider workplace surroundings were associated with slightly higher reported mental wellbeing, although the strength of these relationships was small.

4.11.4 Total workplace environmental greenery

In the workplace setting, total environmental greenery within the surrounding buffers showed similarly weak relationships with mental wellbeing. For the 300 m buffer, Spearman's correlation indicated a small and non-significant positive association between total greenery

and WHO-5 wellbeing scores (p = 0.149). At the broader 900 m buffer, the correlation strengthened slightly and reached statistical significance (p = 0.023).

Although the magnitude of these associations remained small, the significant finding at the 900 m buffer suggests that individuals working in areas characterised by higher overall levels of environmental greenery reported somewhat greater mental wellbeing. These results imply that greener environments in the wider workplace vicinity may contribute to improved mental wellbeing, even if greenery in the immediate surroundings exerts less influence. Therefore, the workplace findings complement those observed for residential greenery, suggesting that exposure to overall green environments, particularly within broader geospatial buffers, may have a limited but potentially positive association with mental wellbeing.

4.12 Regression Analysis

Before conducting the regression analysis, bivariate correlations were performed between each variable and the WHO-5 wellbeing score to identify potential predictors (Table 7). Only variables that demonstrated a statistically significant correlation with WHO-5 at $p < 0.05$ were selected for inclusion in the multivariable model. This ensured that the regression analysis focused on variables with an initial relationship to mental wellbeing. During model building, variables that were not statistically significant in the multivariable analysis were sequentially removed, resulting in the final model presented below (Table 6).

Table 6: Final Multivariable Regression Model Predicting WHO-5 Mental Wellbeing Score

Predictor Variable	***p*-value**
Number of close people one can count on	0.028

Predictor Variable	***p*-value**
Perceived Concern and Positive interest	0.017
Days per week walking ≥10 minutes	0.008
Work Activity	0.019
Overall Model	**<0.001**

Note. This table presents only variables that remained statistically significant in the final multivariable regression model following model refinement. Coefficients, standard errors, and standardised estimates are intentionally omitted, as the primary aim was to compare the relative contribution of each predictor to the explained variance in WHO-5 wellbeing scores.

Table 7: Bivariate correlations between variables and WHO-5 score

Theme	Variable	p-value	Sig.
Housing Conditions	Overcrowding	<0.001	***
	Noise from neighbours or outside	<0.001	***
	Insufficient ventilation	<0.001	***
	Insufficient privacy	<0.001	***
	Leaking roof / damp walls / rot	0.004	**
	Too dark / insufficient light	0.018	*
Social Support & Social Environment	Number of close people one can count on	<0.001	***
	Perceived Concern & Positive interest	<0.001	***
	Ease of getting practical help from neighbours	<0.001	***
	Crime, violence or vandalism in the area	0.063	ns
Green Space Indicators	Residential Grassland 300m	0.040	*

Theme	Variable	p-value	Sig.
	Residential Grassland 900m	0.067	ns
	Residential Tree Canopy 300m	0.834	ns
	Residential Tree Canopy 900m	0.708	ns
	Residential Cropland 300m	0.197	ns
	Residential Cropland 900m	0.384	ns
	Residential Total Greenery 300m	0.216	ns
	Residential Total Greenery 900m	0.063	ns
	Workplace Grassland 300m	0.138	ns
	Workplace Grassland 900m	0.037	*
	Workplace Tree canopy 300m	0.428	ns
	Workplace Tree canopy 900m	0.233	ns
	Workplace Cropland 300m	0.045	*
	Workplace Cropland 900m	0.036	*
	Workplace Total Greenery 300m	0.149	ns
	Workplace Total Greenery 900m	0.023	*

Theme	Variable	p-value	Sig.
Physical Activity (Transport & Leisure)	Daily walking ≥10 min	<0.001	***
	Daily moderate physical activity	<0.001	***
	Daily leisure walking ≥10 min	<0.001	***
	Daily vigorous physical activity	0.002	**
	Daily continuous walking time	0.028	*
	Daily muscle-strengthening activity	0.041	*
	Daily bicycling ≥10 min	0.131	ns
	Daily continuous bicycling time	0.283	ns
Health Status	Presence of chronic illness	<0.001	***
Sedentary Behaviour	Daily sitting/reclining hours	0.007	**
Work Characteristics	Work Activity	0.011	**
Sociodemographic	Gender	0.230	ns
	Age category	0.694	ns
	Education level	0.890	ns

Notes:

- $p < 0.05$
- ** $p < 0.01$
- *** $p < 0.001$

A multivariable model was constructed using the variables that met the correlation threshold (p<0.05). Within this model, predictors were evaluated simultaneously while adjusting for all others. Variables that did not remain statistically significant were considered to offer no independent explanatory value once other factors were accounted for. Several variables, including all environmental greenery indicators did not retain significance at this stage and were therefore excluded from the final interpretation. The refined model thus focused exclusively on predictors that remained statistically significant in the adjusted analysis.

The following four predictors remained statistically significant independent contributors to mental wellbeing. These were:

(1) Number of close people one can count on (p=0.028),

(2) Perceived concern and positive interest shown by others (p=0.017),

(3) Walking frequency, measured as the number of days per week for at least 10 minutes (p=0.008), and

(4) Work activity type (p = 0.019).

4.12.1 Number of close people one can count on

The pairwise comparisons for the variable *How many people in your life are so close to you that you can count on them if you have a serious problem?* provide a more detailed picture of how different levels of social support relate to mental wellbeing among the Maltese population. The clearest finding is that mental wellbeing increases noticeably once individuals have at least three close people they can rely on. This pattern is strongly supported by the statistically significant contrasts (figure 17).

The most important comparison is between the group with no close people and the group with three to five close people. This comparison is statistically significant ($p = 0.029$), with the

group reporting no support scoring substantially lower on mental wellbeing. A similar pattern is observed when comparing the group with one or two to those with three to five close persons. This contrast is also statistically significant ($p = 0.010$), highlighting that having only one or two persons to rely on is associated with significantly lower mental wellbeing than having three to five.

In contrast, the comparisons involving six or more close people do not reach statistical significance. This likely reflects greater variability within this category, possibly due to a smaller sample size or more heterogeneous responses. Conversely, the comparison between the three to five and six or more category is also non-significant ($p = 0.674$), suggesting that once individuals have at least three reliable people in their support network, additional contacts do not correspond to further improvements in mental wellbeing.

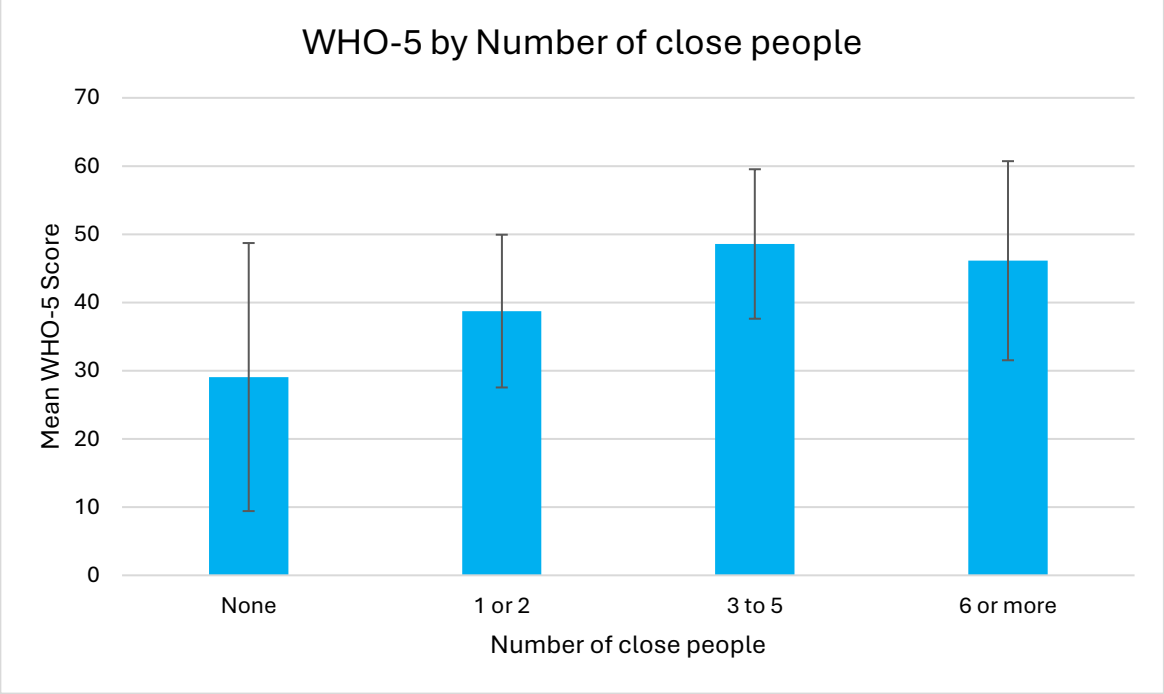

Figure 17: WHO-5 by Number of close people

4.12.2 Perceived Concern and Positive Interest

The pairwise comparisons for perceived concern and positive interest reveal a strong and consistent pattern linking interpersonal recognition to mental wellbeing. Participants who felt that others showed no concern or interest reported substantially lower mental wellbeing than those who perceived moderate or high levels of care. This pattern is supported by several statistically significant contrasts (figure 18). Most notably, individuals in the *no concern and interest* category scored significantly lower than those in the *some concern and interest* category ($p = 0.029$) and the *lot of concern and interest* category ($p = 0.049$). These results indicate that the absence of perceived concern is consistently associated with poorer mental wellbeing.

A similar pattern is observed when comparing the *little concern and interest* category with the higher levels of perceived care. The comparison between *little concern and interest* category and some *concern and interest* category is statistically significant ($p = 0.011$). This suggests that even a modest increase in perceived concern from *little* to *moderate concern and interest* corresponds to a notable improvement in mental wellbeing. The comparison between the *little* category and *lot of concern and interest* category approached statistical significance ($p = 0.057$), indicating a trend toward higher mental wellbeing among those perceiving stronger concern even if the evidence is slightly less robust.

The contrasts involving the *not sure* category also support this gradient. This category scored significantly lower than the some *concern and interest* category ($p = 0.032$). This reinforces the stepwise pattern; as perceived concern increases, so does mental wellbeing.

The *some concern and interest* category consistently emerges as the benchmark for higher mental wellbeing, showing significant differences when compared with the *no concern and*

interest (*p = 0.029*), *little concern and interest* (*p = 0.011*), and *not sure* (*p = 0.032*) categories respectively. The *lot of concern and interest* category also shows significant differences compared with *no concern and interest* category (*p = 0.049*), indicating that high perceived concern is also associated with improved mental wellbeing.

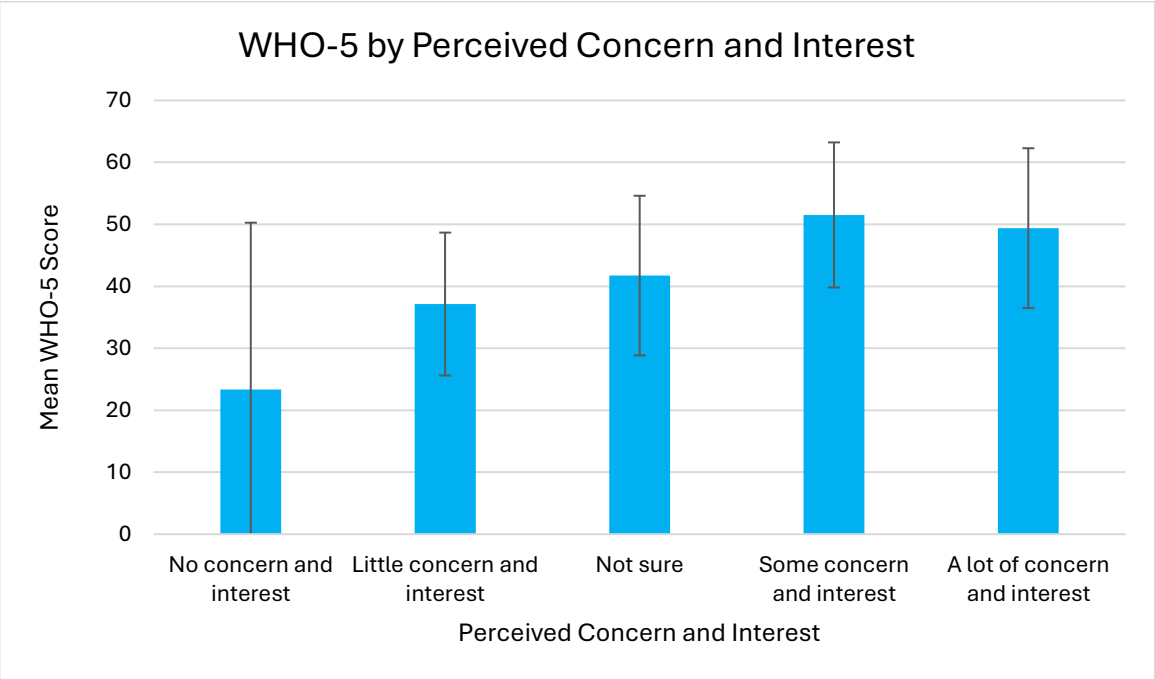

Figure 18: WHO-5 by Perceived Concern and Interest

4.12.3 Work Activity

The pairwise comparisons for work activity type show clear differences in mental wellbeing between the various occupational categories reported by participants. These findings indicate that the nature of one's work is meaningfully associated with mental wellbeing. Specifically, the work description of *mostly walking or tasks of moderate physical effort* (MWMFE) emerged as the group with significantly higher mental wellbeing scores compared with the other categories (figure 19).

The most robust contrast is between *not performing any working tasks* category and MWMFE category. Participants in the *not performing any working tasks* category scored significantly lower in mental wellbeing compared with those in the MWMFE category ($p = 0.019$. The MWMFE category also differs significantly from the *mostly sitting or standing* category ($p = 0.005$). These findings highlight the MWMFE category as a distinctively beneficial work context in terms of mental wellbeing.

In contrast, the comparisons involving *mostly heavy labour* category are not statistically significant. For example, this category versus the MWMFE category yielded a *p*-value of 0.396.

Comparisons between other categories also fail to reach significance, with confidence intervals that cross zero, further indicating that these groups do not differ reliably in mental wellbeing. In these cases, mental wellbeing scores appear more similar, or the variability within groups is too large to detect clear distinctions.

Overall, the pairwise analysis reveals a strong, focused pattern where the MWMFE category consistently stood apart as the only work activity type associated with significantly higher levels of mental wellbeing.

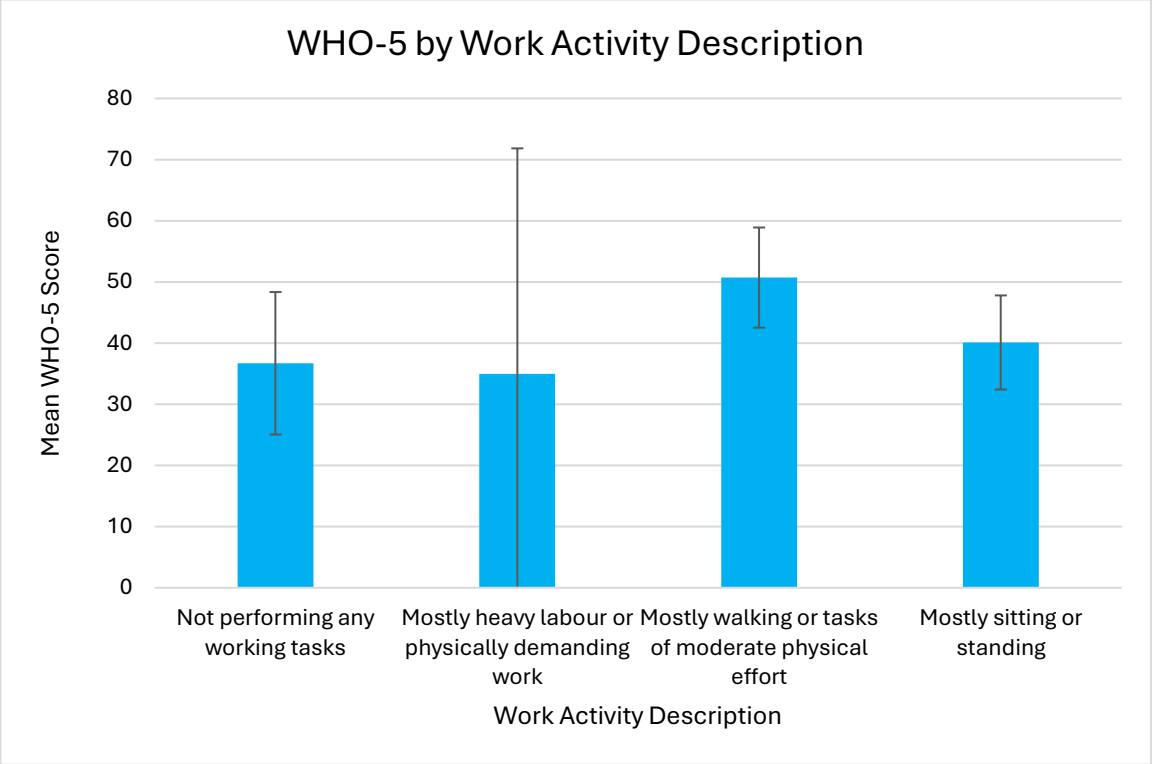

Figure 19: WHO-5 by Work Activity Description

4.12.4 Physical Activity

The multivariable regression results also highlight the relevance of routine physical activity, with more frequent walking associated with better mental wellbeing (figure 20). Walking serves not only as a health behaviour but may also reflect opportunities for mobility, safer neighbourhoods, and a sense of environmental familiarity. Regular walking may represent both a practical means of transportation and a coping mechanism to manage stress. The significance of walking in the model reinforces the importance of accessible, walkable environments and the need to address potential barriers, such as unsafe streets or long working hours, which may limit physical activity.

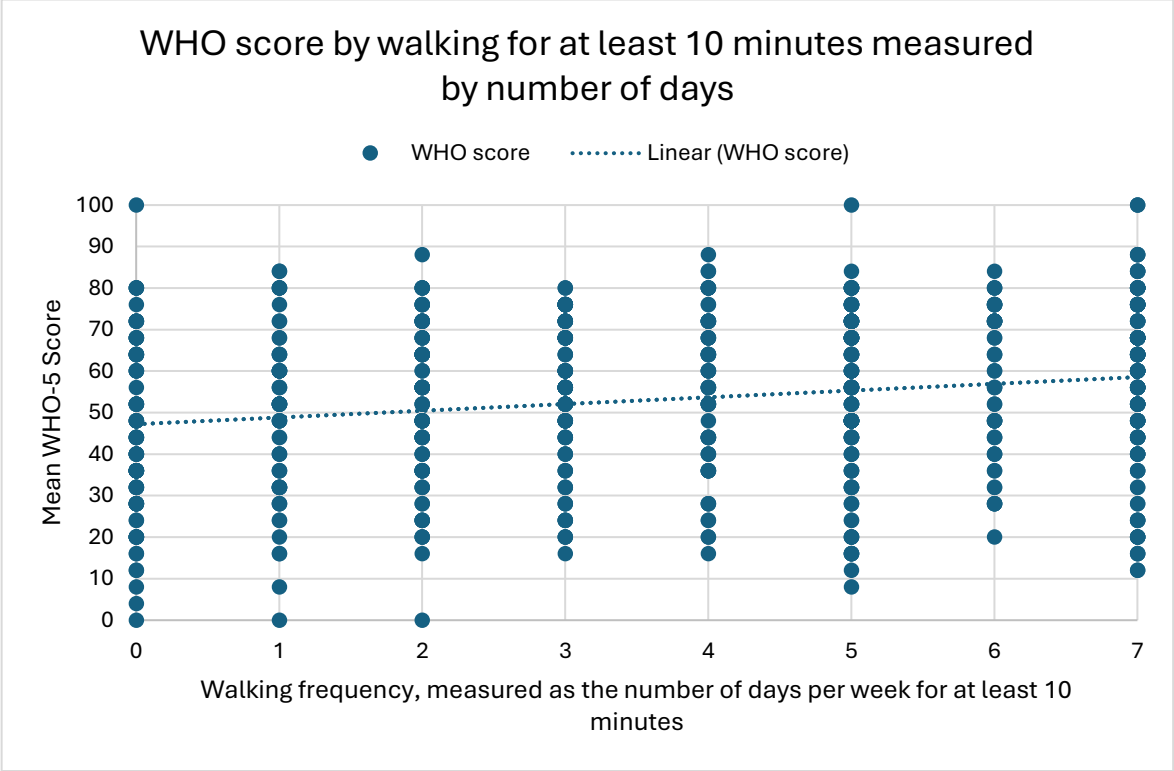

Figure 20: WHO score by walking for at least 10 minutes measured by number of days

Overall, the pairwise results show that social connectedness, interpersonal trust, supportive relationships, and everyday physical and work-related routines are central determinants of mental wellbeing in Malta. These findings suggest that interventions aiming to improve mental wellbeing should not focus solely on material or environmental factors, but should also prioritise strengthening social networks, fostering inclusive community environments, promoting regular physical activity, and addressing vulnerabilities linked to the types of work. By doing so, health promotion efforts can better align with the lived realities and address the interpersonal and structural determinants that most strongly influence mental wellbeing.

Chapter 5: Discussion

5.1 Introduction

This chapter discusses the key findings from the present study examining the association between objectively measured environmental greenery and mental wellbeing among adults residing in Malta. The analysis explored how different types of environmental greenery within 300 m and 900 m buffer zones around participants' residential and workplace locations were associated with scores on the WHO-5 Index. These relationships were assessed through both bivariate correlation and regression analyses, controlling for demographic, health, social, behavioural, and environmental factors.

The rationale for this research was grounded in growing international evidence that exposure to natural environments can enhance psychological wellbeing, reduce stress, and promote healthier lifestyles (Hartig et al., 2014; Dadvand et al., 2016; Markevych et al., 2017).

The discussion that follows below interprets the empirical findings in light of existing literature and theoretical frameworks such as the Stress Reduction Theory (Ulrich, 1984) and Attention Restoration Theory (Kaplan, 1995), which posit that natural environments support emotional recovery and cognitive restoration. Furthermore, the discussion contextualises the findings within Malta's socio-environmental landscape and explores implications for public health policy and urban design.

By contextualising interpretation of the quantitative findings of this study within the existing body of research, this chapter aims to provide a holistic understanding of how environmental greenery influences mental wellbeing in the Maltese adult population, while identifying directions for future research and intervention.

5.3 Comparison with the Literature Review

5.3.1 Residential Greenery and Mental Wellbeing

The positive association between residential grassland at 300 m buffer and mental wellbeing in the study is consistent with evidence reporting a positive association between closer proximity to natural, open, and grassy environments, and improved psychological wellbeing. For instance, Dadvand et al. (2016) demonstrated that residents living within 300 m of green spaces in urban areas exhibited higher mental health scores, a pattern similarly observed by Astell-Burt et al. (2019) in a large Australian cohort. These authors proposed that nearby grass and vegetated areas afford opportunities for passive restoration, visual relief, and recreational activity, aligning with the mechanisms proposed by the Stress Reduction Theory (Ulrich, 1984) and Attention Restoration Theory (Kaplan, 1995).

The attenuation of this association at the 900 m buffer in the current study supports the concept of 'everyday nature' discussed by van den Berg et al. (2017), who found that the psychological benefits of green exposure diminish with increasing distance. In the Maltese context, where the built environment is compact and residential proximity to environmental greenery is often limited, even small patches of grassland may hold tangible psychological value by providing visual or accessible restorative settings within walking distance. This claim is supported by the literature which shows that exposure to small-scale, regularly encountered greenery may promote micro-restorative experiences that accumulate to support mental wellbeing (Kaplan, 1995; Hartig et al., 2014).

However, the non-significant association between total residential greenery and mental wellbeing observed in this study underscores that not all types of greenery contribute equally to mental health. As highlighted by Akpinar et al. (2016), the quality, type, and ecological

composition of environmental greenery can strongly influence the direction and magnitude of health benefits. In the current study, the inclusion of multiple land covers within the 'total greenery' measure may have diluted the specific restorative effects linked to accessible grassland areas. This finding echoes the argument made by Markevych et al. (2017) that quantity alone is an insufficient predictor of mental wellbeing; rather, the perceived quality and usability of environmental greenery are central determinants.

Both the bivariate correlation and regression analyses revealed that residential tree canopy within 300 m was not correlated with mental wellbeing. This counterintuitive relationship contrasts with the positive effects reported in much of the literature (Astell-Burt et al., 2013; Kruize et al., 2020), where tree canopy coverage above 30% has been linked to lower depression and higher life satisfaction. Yet, as Yue et al. (2022) and Fisher et al. (2022) observed, urban tree cover can have neutral or even adverse associations with mental wellbeing in certain contexts, particularly when dense tree-lined streets coincide with high levels of noise, air pollution, and traffic. In Malta, where most tree canopy occurs along major roads or in small clusters within urbanised zones, it is plausible that these environmental stressors coexist with environmental greenery, diminishing its psychological benefits. This aligns with evidence reviewed in the literature review indicating that contextual quality, such as noise, safety, and air quality modifies the restorative potential of natural settings (Dzhambov et al., 2018).

This study did not find a statistically significant association between mental wellbeing and residential cropland. However, studies conducted in peri-urban and rural European settings, such as those by van den Berg et al. (2010) showed that agricultural landscapes contributed to positive affect and reduced psychological distress. Cropland may provide open vistas and a

sense of spaciousness, both of which have been associated with tranquillity and cognitive restoration. From a theoretical standpoint, such settings align with the biophilia hypothesis, suggesting that humans possess an innate preference for natural and semi-natural environments (Kellert & Wilson, 1993). In Malta, cropland may also represent areas of lower urban density, less traffic, and reduced noise. These are factors that indirectly enhance perceived mental wellbeing.

There was no statistically significant association between total environmental greenery within 300 m and mental wellbeing (p = 0.216). Although residential total greenery approached statistical significance (p = 0.063). While initially unexpected, this finding mirrors results from Akpinar et al. (2016), who found that aggregated measures of greenery sometimes masked beneficial relationships when specific vegetation types had opposing effects. In Malta's case, areas classified as 'green' may include degraded, inaccessible, or industrially influenced plots. Thus, the 'greenness' quantified in satellite data may not correspond to perceived restorative greenery. This distinction between objective and subjective green exposure was underscored in the literature by van den Berg et al. (2017) and Dzhambov et al. (2018), who emphasised that the perception of greenery's quality, safety, and accessibility is a stronger predictor of wellbeing than vegetation coverage *per se*.

In summary, the residential findings align with international evidence showing that proximity to accessible grassland can benefit mental wellbeing, but they also illustrate that the effects of greenery are context dependent. The Maltese landscape, characterised by limited continuous vegetation, dense built environments, and varying environmental quality, likely influences both the strength and direction of these associations.

5.3.2 Workplace Greenery and Mental Wellbeing

The pattern of workplace environmental greenery associations with mental wellbeing differed from that observed in the residential setting. In the bivariate analysis, several workplace greenery indicators showed statistically significant positive associations with WHO-5 scores. Specifically, grassland within 900 m of the workplace was significantly associated with higher wellbeing ($p = 0.037$), as were cropland within both 300 m and 900 m ($p = 0.045$ and $p = 0.036$, respectively), and total workplace greenery within 900 m ($p = 0.023$). In contrast, workplace tree canopy within both 300 m and 900 m was not significantly associated with mental wellbeing, and immediate (300 m) workplace grassland and total greenery also remained non-significant.

These findings suggest that, at the bivariate level, participants working in areas characterised by more extensive surrounding grassland, cropland, and overall greenery tended to report slightly higher mental wellbeing. This is broadly consistent with international evidence indicating that visible greenery in and around occupational settings can contribute to stress reduction and cognitive restoration, especially when workers have visual access to natural environments during the working day or commute (Kaplan, 1995; Dadvand et al., 2016; Bakhtsiyarava et al., 2024).

The stronger pattern at 900 m compared with 300 m mirrors the idea of “everyday nature” operating at the scale of routine travel corridors and wider neighbourhood surroundings rather than only the immediate workplace surroundings.

However, when these indicators were entered into the multivariable regression model alongside social, behavioural, health, and work-related factors, none of the workplace

greenery variables retained statistical significance and were sequentially removed during model refinement. The final model identified other variables as the key independent predictors of mental wellbeing. This attenuation is consistent with literature emphasising that the mental wellbeing benefits of greenery are often mediated through physical activity, social cohesion, and broader environmental quality rather than operating as strong independent predictors once these factors are accounted for (Markevych et al., 2017; Astell-Burt & Feng, 2019).

From a contextual perspective, the significant yet modest workplace associations likely reflect a combination of genuine exposure effects and underlying environmental patterns in Malta. In a compact small-island setting where residential and workplace environments often overlap, greener workplace surroundings may mark less dense, less polluted, or less noisy areas rather than acting solely as an occupational exposure.

Furthermore, the land-cover categories that showed significant associations may also represent areas of lower traffic and quieter surroundings, which aligns with the wider literature on environmental stressor mitigation as a pathway to improved mental wellbeing. At the same time, the lack of independent effects in adjusted models underlines that workplace greenery alone is insufficient to drive mental wellbeing. Its influence appears to be modest and intertwined with social support, occupational conditions, and patterns of physical activity.

These results therefore support the broader conclusion from the literature review that workplace greenery can contribute to mental wellbeing, but primarily as part of a wider

constellation of social and environmental factors rather than as a dominant, stand-alone determinant.

5.3.3 Mediating Pathways and Theoretical Context

The regression analysis provided important clarification on how mental wellbeing is shaped within the Maltese context and how these pathways compare to the theoretical mechanisms identified in the literature review. Although several types of workplace environmental greenery showed statistically significant correlations with mental wellbeing in the bivariate analysis, none of the residential or workplace greenery variables remained statistically significant in the multivariable regression models. Instead, the predictors that consistently demonstrated independent associations with WHO-5 scores were number of close people, perceived concern and interest from others, physical activity (walking), and work activity type.

These findings indicate that the relationship between environmental greenery and mental wellbeing is largely indirect in this dataset. Theories such as the Stress Reduction Theory (SRT) and Attention Restoration Theory (ART) propose that natural environments confer psychological benefits by reducing stress and supporting cognitive restoration. Similarly, the literature identifies environmental greenery as a potential enabler of physical activity and social cohesion, both of which are important for mental wellbeing. However, the present results suggest that in Malta, these behavioural and social mechanisms exert stronger influence than greenery exposure itself once all variables are considered concurrently.

One of the predictors, number of close people, aligns closely with theoretical pathways emphasising social cohesion as a key mediator between environment and mental wellbeing. Individuals with larger supportive networks experience greater emotional resilience and have more resources to cope with daily challenges, regardless of their environmental exposures.

The literature consistently highlights social support as both a mediator and an independent driver of mental wellbeing, and this study reinforced its primacy within small, densely populated communities. The significant effect of perceived concern and interest similarly reflects the importance of relational and emotional connectedness.

Physical activity, measured through walking frequency, was another significant predictor, consistent with extensive evidence showing that green environments often promote mental wellbeing by encouraging active lifestyles. Although greenery did not maintain significance independently, the presence of a behavioural predictor in the final model suggests a plausible pathway in which environmental features may still facilitate physical activity indirectly. Yet, within this dataset, physical activity exerted influence regardless of environmental greenery exposure, implying that Maltese adults may engage in walking for reasons unrelated to green surroundings, such as commuting patterns, cultural norms, or the compact urban form.

The association between work activity type and mental wellbeing adds further nuance. Participants engaged in more physically demanding or labour-intensive roles reported lower mental wellbeing compared to those in sedentary or mixed work environments. This reflects that certain occupational stressors may outweigh any potential benefits of greener workplace environments. As seen in the regression models, even when certain types of workplace greenery showed significant bivariate associations, occupational characteristics overshadowed these effects in the multivariable context.

The findings therefore suggest that theoretical pathways linking environmental greenery and mental wellbeing may operate through behavioural and social processes, but these pathways are not strong enough to produce independent statistical effects when analysed alongside more proximal individual determinants. This aligns with emerging international

literature indicating that environmental greenery's benefits are often contingent upon supportive social environments, opportunities for meaningful use, perceived safety, and behavioural engagement

5.4 Contextualising the Findings in Malta

The findings of this study must be interpreted within Malta's distinctive geographical, demographic, and environmental context. Malta is a densely populated country, with 1,649 persons per square kilometre (NSO, 2023). This density, coupled with rapid urbanisation and limited land resources, has substantially altered the natural landscape over recent decades. The expansion of built-up areas, the conversion of agricultural land to urban areas, and the scarcity of public green spaces have collectively contributed to a highly urbanised environment where access to restorative natural settings is unevenly distributed. These structural and spatial constraints likely influenced both the level of greenery exposure recorded in this study and the magnitude of its association with mental wellbeing.

The modest levels of grassland and tree canopy cover observed in the study reflect Malta's limited vegetation and fragmented green infrastructure. As noted in local environmental reports (ERA, 2021), the majority of remaining greenery exists in small patches, agricultural fields, or peripheral rural areas rather than within urban neighbourhoods. The mean grassland cover of 11.2% within 300 m buffers and tree canopy coverage of only 4% highlight the scarcity of nearby green environments for many residents. This limited availability may explain why only small effect sizes were observed in the correlations with mental wellbeing. In essence, this limited availability of greenery means that relatively few participants in the cohort were meaningfully exposed to natural environments, and even those classified as 'exposed' often experienced only minimal levels of greenery. Such restricted and low-intensity exposure

dilutes the variability required to detect stronger statistical associations, thereby contributing to the small effect sizes observed—a pattern also noted in studies conducted in similarly compact and densely built urban settings (de Keijzer et al., 2020).

Climatic and environmental factors further complicate the relationship between environmental greenery and mental wellbeing in Malta. The Mediterranean climate, characterised by long, hot summers and limited rainfall, restricts the growth and maintenance of vegetation, particularly tree canopy. High summer temperatures can reduce outdoor activity and limit the use of green spaces for recreation, attenuating the potential for physical and social engagement that typically mediates the relationship between environmental greenery and mental wellbeing (Astell-Burt & Feng, 2019). Studies conducted in southern Europe, such as those by Dadvand et al. (2016) and van den Berg et al. (2017), also found that climatic conditions and heat exposure significantly influence the restorative value of green environments. In the Maltese context, shaded or well-maintained areas may provide greater comfort and perceived quality.

Cultural factors and land-use traditions may also shape how environmental greenery is perceived and utilised in Malta. Maltese residents often engage with the natural environment through coastal and agricultural landscapes rather than urban parks (Borg, 2022; Camilleri, 2023). Cropland, therefore, may hold cultural and aesthetic value, symbolising openness, heritage, and tranquillity. This could partially explain the positive relationship observed between cropland cover and mental wellbeing in this study. Similar findings have been documented in other Mediterranean countries, where agrarian settings provide both visual and psychological respite from dense built environments (van den Berg et al., 2010; Richardson

et al., 2021). However, agricultural areas in Malta are increasingly fragmented or encroached upon by development, limiting their accessibility for everyday restorative experiences.

The spatial pattern of environmental stressors in Malta also provides important context for interpreting the results. noise and perceived pollution were among the most common living environment problems reported by participants. These exposures are well recognised in the literature as undermining the psychological benefits of green environments (Yue et al., 2022; Yang et al., 2025). In Malta, where many urban areas combine limited greenery with high traffic volumes, the proximity of trees or green strips to busy roads may exacerbate rather than alleviate stress. This interplay may account for the negative associations found between residential tree canopy and mental wellbeing.

The environmental justice perspective (Kruize et al., 2020) is relevant here. Environmental greenery in Malta may be unevenly distributed, with wealthier neighbourhoods enjoying access to landscaped areas, while denser, lower-income zones experience higher pollution and less greenery, thereby reinforcing health inequities.

The relatively weak associations between environmental greenery and mental wellbeing found in this study are therefore unsurprising when contextualised within Malta's built and social environment. As highlighted by Desira (2014) and subsequent national health promotion reports, public green infrastructure in Malta remains underdeveloped and often disconnected from daily living spaces. The scarcity of large, continuous parks limits opportunities for physical activity and social cohesion; two of the key mediating pathways identified in Chapter 2. Moreover, existing small-scale green areas are often privately owned or poorly maintained, reducing their accessibility and perceived safety. Consequently, while residents may

experience visual contact with environmental greenery, opportunities for direct interaction or recreation are limited, potentially explaining the modest mental wellbeing benefits observed.

It is also important to consider Malta's compact geography and short travel distances, which blur the distinction between residential and workplace exposures. The positive associations between workplace environmental greenery and mental wellbeing observed in this study may therefore reflect broader neighbourhood characteristics rather than strictly workplace-specific environments. In a small island setting, many individuals live and work within overlapping environmental zones; hence, their total exposure to environmental greenery may be influenced by cumulative rather than discrete spatial factors.

The findings hold broader implications for urban and environmental policy in Malta. Initiatives such as the National Strategy for the Environment (2021–2030) and the Urban Greening Scheme aim to enhance the quality and quantity of green infrastructure across localities. The current results underscore the importance of implementing these strategies with a focus on equity, accessibility, and environmental quality. Interventions should prioritise creating small, well-designed, and shaded urban green spaces within residential areas, improving maintenance, and integrating greenery with pedestrian and cycling networks to encourage active use. Such measures align with the Healthy Cities framework advocated by the World Health Organization, which emphasises the integration of environmental sustainability and mental wellbeing in urban planning.

Characterised by limited and fragmented green space, climatic constraints, and environmental pressures, the Maltese context provides a plausible explanation for the modest and variable associations observed between environmental greenery and mental wellbeing. These findings reinforce the argument that the health benefits of nature are context-

dependent and that enhancing the quality, accessibility, and integration of greenery within Malta's urban fabric is crucial to achieve meaningful public health gains.

5.5 Study Strengths and Limitations

Every research study has methodological strengths and inherent limitations that must be acknowledged to enable accurate interpretation of its findings. The present study, which examined associations between environmental greenery and mental wellbeing among adults in Malta, combined several methodological advantages while facing practical and contextual constraints that shape the conclusions drawn.

One of the key strengths of this study lies in its use of objective spatial measures of greenery derived from geographic information systems (GIS). This approach minimised the recall and reporting bias typically associated with self-reported exposure to green environments. By quantifying four distinct greenery categories; grassland, tree canopy, cropland, and total green cover, within two buffer distances around both residential and workplace locations, the study achieved a high degree of spatial precision. This allowed for a more nuanced analysis of environmental exposure than studies that rely solely on satellite-derived vegetation indices such as NDVI. The inclusion of workplace buffers represents an additional methodological advancement, as few studies in small-island settings have simultaneously examined residential and occupational environmental green exposure, despite individuals spending substantial portions of their day outside the home.

Another strength concerns the use of the WHO-5 Wellbeing Index, a validated, concise, and internationally comparable measure of subjective mental wellbeing. Its robust psychometric properties enable meaningful comparison with studies in other European contexts. Furthermore, the analytical approach, combining descriptive, bivariate, and multivariable

regression analyses, provided a systematic exploration of both unadjusted and adjusted associations, allowing confounding influences to be accounted for. The relatively large sample size, encompassing of 691 participants, adds statistical power and permitted the exploration of subgroup differences across age, gender, and environmental factors.

Despite these strengths, several limitations should be considered when interpreting the findings. First, the cross-sectional design precludes the establishment of causal relationships. While associations between environmental greenery and mental wellbeing were identified, the direction of effect cannot be confirmed. Individuals with higher mental wellbeing may be more likely to live in greener areas, a form of residential self-selection bias. Longitudinal or quasi-experimental designs would be required to confirm causality.

Second, although environmental greenery exposure was objectively measured, the study did not assess subjective perceptions such as quality, accessibility, safety, or frequency of use of green spaces. As emphasised in the literature review, perceived quality often predicts mental wellbeing more strongly than objective greenness alone (Dzhambov et al., 2018). The lack of qualitative or perceptual data may therefore have limited insight into how participants experienced their surrounding environments.

Third, while the GIS layers were derived from high-resolution national datasets, classification errors and temporal mismatches may have introduced measurement bias. Some green areas captured in the data may have changed since dataset publication, particularly in rapidly developing regions. Additionally, buffer-based exposure metrics assume uniform use of space within defined radii, which may not accurately reflect participants' daily mobility patterns or time spent in green environments.

The sample composition may also constrain generalisability. Women and highly educated individuals were over-represented, and recruitment through voluntary participation may have attracted health-conscious respondents. Consequently, the findings may not fully represent the demographic diversity of the Maltese population. Furthermore, unmeasured variables, such as personality traits, occupational stress, or household income, may have confounded the observed associations despite multivariable adjustment. [Although you attempted to mitigate this by recruiting participants from more than on setting]

Lastly, the study was conducted during a period of social and environmental transition in Malta, including post-pandemic shifts in work routines and mobility patterns. These contextual dynamics may have influenced both exposure to environmental greenery and perceived mental wellbeing, adding an additional layer of complexity to interpretation.

In summary, this study's methodological robustness, particularly its objective spatial approach and comprehensive adjustment for confounders, strengthens confidence in the internal validity of its findings. Nevertheless, its cross-sectional nature, potential exposure misclassification, and limited representativeness temper the extent to which causal or population-wide inferences can be drawn. Recognising these limitations is essential for guiding the interpretation of results and informing future research design, as discussed in the subsequent sections.

5.6 Implications for Public Health Policy and Practice

The findings of this study have several important implications for public health policy, urban planning, and community wellbeing in Malta. Although the associations between environmental greenery and mental wellbeing were modest, they nonetheless highlight a measurable relationship between contact with natural environments and psychological health.

These results reinforce the growing consensus, outlined in international and national frameworks, that environmental design and land-use planning are integral components of public health policy.

5.6.1 Promoting Mental Wellbeing through Urban Design

The observed positive associations between residential grassland and mental wellbeing, as well as between workplace tree canopy and mental wellbeing, underscore the need to integrate natural features into everyday living and working environments. Even small-scale, accessible greenery appears to contribute to better mental wellbeing outcomes, aligning with the principles of the WHO Healthy Cities initiative, which advocates for cities that support health through environmental and social design.

Urban planning authorities, such as the Planning Authority and the Environment and Resources Authority (ERA), could incorporate these insights into Local Plans and Development Guidelines, ensuring that new developments include green microspaces such as pocket parks, shaded streets, and vegetated courtyards, including initiatives undertaken by Project Green.

Moreover, urban design policies should prioritise quality over quantity of greenery. As international research (Markevych et al., 2017; Kruize et al., 2020) and the current study both demonstrate, not all greenery confers equal benefits. Green areas adjacent to polluted or noisy roads may be less restorative than smaller, well-maintained spaces situated in quieter residential zones. The integration of vegetative buffers, green roofs, and tree canopies in strategic locations can enhance shade, reduce heat stress, and mitigate air and noise pollution, all of which were identified as potential barriers to mental wellbeing in this study.

5.6.2 Equity and Accessibility in Green Space Distribution

The results also draw attention to potential inequities in access to restorative environments. In Malta's densely built urban areas, green spaces are limited and unevenly distributed, with certain localities, particularly those of lower socioeconomic status, having fewer accessible public parks or natural areas. This aligns with the environmental justice concerns discussed by Kruize et al. (2020), whereby socially disadvantaged communities are more likely to experience limited access to environmental greenery and higher exposure to environmental stressors. Policymakers should therefore adopt an equity-based approach to urban greening, prioritising investment in under-served neighbourhoods.

Initiatives such as the Urban Greening Scheme and the National Strategy for the Environment (2021–2030) provide policy levers for achieving this. However, to maximise public health benefits, these programmes must be guided by evidence-based design principles that enhance the perceived safety, accessibility, and usability of green spaces. Incorporating community consultation during the planning process can also strengthen social cohesion, one of the mediating pathways linking environmental greenery to mental wellbeing identified in this study and in international literature.

5.6.3 Integrating Health into Environmental Policy

The findings further emphasise the need to mainstream mental health considerations into environmental and infrastructural policymaking. Current health promotion efforts in Malta predominantly focus on lifestyle risk factors such as diet, smoking, and physical inactivity. Yet, as demonstrated by this research and supported by the literature, the built and natural environments are also social determinants of health. Integrating environmental indicators,

such as access to environmental greenery or exposure to pollution, into the Health in All Policies (HiAP) framework could facilitate cross-sectoral collaboration between Ministries and entities.

For example, joint initiatives between public health authorities and urban planners could promote the co-design of green corridors that encourage active transport, such as walking and cycling, while simultaneously offering psychological restoration. Such interventions would contribute to both physical and mental health promotion, aligning with the European Green Deal and the EU Biodiversity Strategy for 2030, which call for urban areas to become healthier, more resilient, and more sustainable.

5.6.4 Public Health Practice and Community Engagement

From a practical perspective, the findings highlight opportunities for health promotion initiatives to broaden their engagement in community-based environmental health actions. Public health campaigns could raise awareness of the mental wellbeing benefits of nature contact and encourage residents to make use of existing green spaces, coastal paths, and rural trails. Partnerships with local councils could facilitate programmes such as ‘green walks’, community gardening, or urban tree-planting initiatives that promote both environmental stewardship and mental wellbeing. Importantly, schools represent a valuable setting for such efforts. Greening school grounds and integrating nature-based activities into educational programmes could help cultivate environmental awareness from a young age while providing restorative benefits for students, teachers, and the wider school community.

6 Recommendations

6.1 Recommendations for Future Research

The findings of this study highlight several important areas for future investigation. While the results provide an initial evidence base linking environmental greenery to mental wellbeing in Malta, further research is required to clarify causal pathways, strengthen methodological rigour, and broaden the understanding of contextual influences.

Longitudinal and experimental designs are needed to establish temporal and causal relationships between environmental greenery exposure and mental wellbeing. The cross-sectional design of the current study limits causal inference. Future research shall employ prospective cohort studies or natural experiments to observe how changes in environmental greenery, such as urban greening initiatives affect mental wellbeing over time. These designs would also help determine whether the observed associations persist, strengthen, or diminish following exposure changes.

Future studies should incorporate subjective measures of environmental greenery quality and use, in addition to objective GIS-based indicators. While this study quantified environmental greenery objectively, perceived characteristics such as accessibility, safety, aesthetics, and maintenance strongly influence the psychological benefits derived from nature contact. Mixed-method approaches combining quantitative and qualitative data, such as surveys or focus groups, could provide richer insight into how Maltese residents experience and value their local green environments.

Given the complex interactions between environmental and social determinants of health, future research should examine mediating and moderating variables more comprehensively. For example, variables such as perceived social cohesion, neighbourhood safety, physical

activity, and noise or air pollution exposure could be explored to disentangle direct and indirect effects. This would improve the understanding of the pathways through which environmental greenery influences mental wellbeing, as suggested by the conceptual frameworks of Hartig et al. (2014) and Markevych et al. (2017).

The findings also indicate that exposure to environmental greenery cannot be considered in isolation, as different geographical areas expose individuals to a wider mosaic of environmental and social determinants of mental wellbeing, including noise, pollution, workplace conditions, traffic patterns, and social stressors. These coexisting factors may independently influence mental wellbeing and can modify or limit the impact of environmental greenery alone. Future research should therefore adopt a systemic approach; one that accounts for these interacting determinants alongside the measurement of environmental greenery to generate a more comprehensive understanding of how environmental and social conditions jointly shape mental wellbeing in Malta.

Additionally, population diversity should be addressed in future sampling. Oversampling of men, older adults, and lower socioeconomic groups would improve representativeness and permit subgroup analyses to identify vulnerable populations who may benefit most from environmental interventions. As shown in the literature, children, adolescents, and older adults tend to experience distinct restorative responses. Therefore, research in these groups would be particularly valuable.

Finally, integration with environmental monitoring data such as noise, air quality, and temperature could enable multi-exposure modelling to assess the combined impact of environmental factors on mental wellbeing.

6.2 Recommendations for Policy

The findings of this study have provided novel insights into the relationship between environmental greenery and mental wellbeing within the Maltese context. By employing objective GIS-based measures of environmental greenery and examining their associations with self-reported mental wellbeing, the study has demonstrated that the influence of natural environments on mental health is both context-specific and multifactorial.

A first and central recommendation concerns the integration of mental wellbeing within urban and environmental planning processes. The findings demonstrated that accessible, everyday environmental greenery close to residential environments, such as grassland within 300 metres, was significantly associated with better mental wellbeing. This suggests that proximity and accessibility are key determinants of psychological benefit. Therefore, planning authorities and local councils should prioritise the incorporation of small, accessible green areas within residential zones, particularly in densely built urban localities. The evidence from this study suggests that even modest environmental green exposures in daily life can make a measurable difference to mental wellbeing. Therefore, ensuring that such exposures are available equitably across the island could yield cumulative public health benefits. The implications of this recommendation are far-reaching. Integrating mental wellbeing into environmental policy would ensure that green infrastructure is recognised not only for its ecological value but also for its contribution to human health, thereby aligning local development with the broader public health agenda.

A second recommendation arises from the finding that the quality and type of environmental greenery matter as much as its quantity. The non-significant associations observed between total environmental greenery and mental wellbeing, suggest that not all

green environments are inherently beneficial. In the Maltese context, this may be attributed to tree-lined streets adjacent to busy roads or to inaccessible vegetated land that provides little opportunity for restorative engagement. Therefore, environmental initiatives should shift focus from merely increasing vegetative cover to ensuring that environmental greenery is safe, accessible, visually appealing, and perceived positively by residents. Enhancing the quality of existing green spaces, through regular maintenance, improved accessibility, shading, and amenities, may have a more pronounced impact on mental wellbeing than large-scale but poorly designed greening projects. The consequences of overlooking this aspect are clear. Without attention to quality and usability, investments in environmental greenery may fail to achieve their intended psychological and health outcomes.

In parallel, it is important to recognise the role of blue spaces, such as coastal areas, and the sea, as potential contributors to mental wellbeing. Although outside the scope of the present study, international evidence indicates that exposure to blue environments can offer restorative benefits comparable to, and in some cases stronger than, those of green spaces. In a small island state like Malta, where the availability of accessible greenery is limited, blue spaces may serve as an important compensatory resource for psychological restoration and stress relief. This underscores the need to safeguard existing coastal zones and prevent further encroachment, ensuring that these environments remain accessible, of high-quality, and protected for public benefit.

Workplaces may still benefit from incorporating accessible and well-designed green features, such as shaded outdoor areas, landscaped seating spaces, or visually appealing green views, as part of comprehensive mental wellbeing efforts. These enhancements can support relaxation, provide brief restorative opportunities, and contribute to a more supportive

working environment, even if not all objective environmental greenery measures were not strongly predictive in this study. Such approaches should complement existing workplace health promotion initiatives, ensuring that greenery is integrated in a way that enhances daily employee experience rather than relying solely on surrounding land-cover characteristics.

The study also underscores the importance of addressing environmental stressors such as noise, pollution, and overcrowding, which emerged as prevalent issues among participants. Nearly half of respondents reported exposure to perceived pollution and more than one-third reported noise problems. These findings suggest that the benefits of environmental greenery can be undermined by concurrent environmental burdens. Therefore, any public health strategy that seeks to harness the benefits of natural environments should also address these coexisting stressors. Urban greening projects should aim not only to beautify but also to buffer environmental harms, for example, by positioning vegetation as noise barriers along traffic corridors or by integrating green infrastructure that improves air quality. The consequence of neglecting this dual approach would be the perpetuation of an environmental paradox: green areas that exist in proximity to residents yet fail to yield mental wellbeing benefits due to poor environmental quality.

Another key finding from this study relates to the role of social cohesion and community support as potential mediators in the relationship between the environment and mental wellbeing. Most participants reported moderate to high levels of social support, yet a notable minority experienced limited connectedness or difficulty obtaining help from neighbours. This social dimension is important because the psychological benefits of green environments are often amplified when they serve as settings for positive social interaction. In Malta, where neighbourhood density is high but social engagement may be declining, urban design that

facilitates community interaction, such as shared courtyards, small parks, and community gardens, could strengthen both social cohesion and mental wellbeing. Thus, promoting community participation in local greening initiatives not only enhances environmental quality but also fosters belonging and mutual support, both of which were shown to be associated with mental wellbeing in this study. The implication is that policies should not treat greenery as a purely physical intervention but as a social infrastructure that enables connection and collective wellbeing.

Furthermore, this research has several implications for public health practice and local health promotion. The observed associations between environmental green exposure and mental wellbeing suggest that encouraging engagement with nature could be a low-cost, community-based strategy to improve mental health. Health professionals, particularly within primary care and public health services, could promote 'green prescriptions' or nature-based wellbeing programmes as part of preventive and rehabilitative care. The findings indicate that most participants engage in walking as their primary form of physical activity, often within short distances of their homes. This behaviour could be leveraged by promoting walking routes that traverse or connect green areas, integrating physical activity with restorative exposure to nature. The consequence of adopting such measures would be twofold, improving mental wellbeing while concurrently fostering physical activity and social engagement.

The recommendations arising from this study converge on a common theme, that is the need to recognise and operationalise environmental greenery as a determinant of mental wellbeing within Malta's public health framework. The evidence demonstrates that the benefits of environmental greenery are contingent upon its proximity, quality, and integration into daily life. To translate these findings into practice, urban and health authorities should

jointly pursue policies that enhance access to high-quality, restorative green environments while mitigating coexisting environmental stressors. Public health programmes should capitalise on nature-based engagement as a tool for promoting psychological resilience, while future research should refine the evidence base through longitudinal and participatory approaches. Implemented together, these actions could contribute to a healthier, more connected, and more sustainable Malta; one where the natural environment is not only protected but actively harnessed to promote the mental wellbeing of the Maltese people.

7 Conclusion

This study provides novel evidence on the relationship between environmental greenery and mental wellbeing among adults in Malta, a context that has been underexplored in the international literature. Using objective GIS-based measurements, the research demonstrated that proximity to certain types of environmental greenery, particularly grassland around residential areas and tree canopy near workplaces, was modestly but significantly associated with higher mental wellbeing. Conversely, total environmental greenery and tree canopy near residences showed weaker or negative associations, reflecting the complexity of environmental influences on mental health in densely built, small-island settings.

When considered alongside the theoretical frameworks and empirical evidence, the study's findings suggest that the psychological benefits of environmental greenery are shaped not merely by the presence of vegetation but by its type, quality, and environmental context. The results lend partial support to both the Stress Reduction Theory (Ulrich, 1984) and Attention Restoration Theory (Kaplan, 1995), while also emphasising the moderating roles of social cohesion, physical activity, and exposure to pollution and noise.

In the Maltese context, limited availability of accessible and high-quality environmental greenery, coupled with high population density and urban stressors, appears to constrain the mental wellbeing benefits of natural environments. Nevertheless, even small patches of nearby green space were found to have measurable positive effects, underscoring their value as a public health resource.

The implications for policy are clear. Improving the quality, accessibility, and equitable distribution of environmental greenery rather than merely increasing its quantity could contribute meaningfully to population mental wellbeing. Future research should adopt

longitudinal and mixed method approaches to clarify causal mechanisms and explore how environmental interventions can best support mental health.

This study adds to the growing body of evidence positioning the natural environment as a determinant of mental wellbeing. It provides a foundation for evidence-informed urban and public health policies in Malta, where fostering greener, healthier, and more restorative spaces can yield sustainable benefits for individual and community wellbeing.

References

Abela, M. (2008). *The benefits of greenery in an urban society with a particular reference to the Maltese Islands - University of Malta*.

Akpinar, A., Barbosa-Leiker, C., Brooks, K. B (2016). Does green space matter? Exploring relationships between green space type and health indicators. *Elsevier*. https://doi.org/10.1016/j.ufug.2016.10.013

Astell-Burt, T., Feng, X., & Kolt, G. S. (2013). Mental health benefits of neighbourhood green space are stronger among physically active adults in middle-to-older age: Evidence from 260,061 Australians. *Preventive Medicine*, *57*(5), 601–606. https://doi.org/10.1016/J.YPMED.2013.08.017

Astell-Burt, T., Feng, X. (2019). Association of urban green space with mental health and general health among adults in Australia. *Jamanetwork.Com*. https://doi.org/10.1001/jamanetworkopen.2019.8209

Bakhtsiyarava, M., Ju, Y., Moran, M., Rodriguez, D., Dronova, I, Declos-Alio, X., Moore, K., Castillo-Ruquelme., Anza-Ramirez, C. (2024). Associations between urban greenspace and depressive symptoms in Mexico's cities using different greenspace metrics. *Applied Geography, Elsevier*. https://doi.org/10.1016/j.apgeog.2024.103219

Van Den Berg, J Maas, RA Verheij, PP Groenewegen. (2010). Green space as a buffer between stressful life events and health. *Elsevier. Social Science & Medicine*. https://doi.org/10.1016/j.socscimed.2010.01.002

Bijnens, E. M., Vos, S., Verheyen, V. v., Bruckers, L., Covaci, A., de Henauw, S., den Hond, E., Loots, I., Nelen, V., Plusquin, M., Schoeters, G., & Nawrot, T. S. (2022). Higher surrounding green space is associated with better attention in Flemish adolescents. *Environment International*, *159*, 107016. https://doi.org/10.1016/J.ENVINT.2021.107016

Borg, J. (2022). *Investigating engagement with nature in the Maltese islands - University of Malta*.

Brennan, M., Mills, G., Ningal, T (2017). *Dublin tree canopy*

Briguglio, M. (2021). *Nature without humans. Humans without nature - University of Malta*.

Callaghan, A., McCombe, G., Harrold, A., McMeel, C., Mills, G., Moore-Cherry, N., & Cullen, W. (2021). The impact of green spaces on mental health in urban settings: a scoping review. *Journal of Mental Health, 30*(2), 179–193. https://doi.org/10.1080/09638237.2020.1755027

Camilleri, V. (2023). *Nature exposure and mental health - University of Malta*.

Capili, B. (2020). How Does Research Start? *The American Journal of Nursing*, *120*(10), 41. https://doi.org/10.1097/01.NAJ.0000718644.96765.B3

Dadvand, P., Bartoll, X., *Basagaña, X., Dalmau-Bueno, A., Martinez, D., Ambros, A., Cirach, M., Trigueoro-Mas, M., Gascon, M., Borrell, C., Nieuwenhuijsen, M.* (2016). Green spaces and general health: roles of mental health status, social support, and physical activity. *Elsevier*. https://doi.org/10.1016/j.envint.2016.02.029

Desira, D. (2014). *Exploring biophilia : the influence of childhood experiences on connectedness to nature in adulthood - University of Malta*.

Diener, A., & Mudu, P. (2021). How can vegetation protect us from air pollution? A critical review on green spaces' mitigation abilities for air-borne particles from a public health perspective - with implications for urban planning. *Science of The Total Environment*, *796*, 148605. https://doi.org/10.1016/J.SCITOTENV.2021.148605

Dzhambov, A., Markevych, I., Hartig, T., Tilov, B., Arabadzhiev, Z., Stoyanov, D., Gatseva, P., Dimitrova, D. (2018). Multiple pathways link urban green-and bluespace to mental health in young adults. *Elsevier*. https://doi.org/10.1016/j.envres.2018.06.004

Ekkel, E. D., & de Vries, S. (2017). Nearby green space and human health: Evaluating accessibility metrics. *Landscape and Urban Planning*, *157*, 214–220. https://doi.org/10.1016/J.LANDURBPLAN.2016.06.008

Feng, X. A.-B. T. (2017). Residential green space quantity and quality and child well-being: a longitudinal study. *Elsevier*. https://doi.org/10.1016/j.amepre.2017.06.035

Fisher, J., Rankin, E., Irvine, K., Goddard, M., Davies, Z., Dallimer, M. (2022). Can biodiverse streetscapes mitigate the effects of noise and air pollution on human wellbeing? *Elsevier*. https://doi.org/10.1016/j.envres.2022.113154

Frumkin, H., Bratman, G. N., Breslow, S. J., Cochran, B., Kahn, P. H., Lawler, J. J., Levin, P. S., Tandon, P. S., Varanasi, U., Wolf, K. L., & Wood, S. A. (2017). Nature contact and human health: A research agenda. *Ehp.Niehs.Nih.Gov*, *125*(7). https://doi.org/10.1289/EHP1663

Gascon, M., Mas, M. T., Martínez, D., Dadvand, P., Forns, J., Plasència, A., & Nieuwenhuijsen, M. J. (2015). Mental Health Benefits of Long-Term Exposure to Residential Green and Blue Spaces: A Systematic Review. *International Journal of Environmental Research and Public*

Health 2015, Vol. 12, Pages 4354-4379, *12*(4), 4354–4379. https://doi.org/10.3390/IJERPH120404354

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health*, *35*(Volume 35, 2014), 207–228. 10.1146/annurev-publhealth-032013-182443

Huang, D., Jiang, B., & Yuan, L. (2022). Analyzing the effects of nature exposure on perceived satisfaction with running routes: An activity path-based measure approach. *Urban Forestry & Urban Greening*, *68*, 127480. https://doi.org/10.1016/J.UFUG.2022.127480

Jennings, V., & Bankole, O. (2019). The relationship between social cohesion and urban green space: An avenue for health promotion. *Journal of Environmental Research and Public Health. https://www.mdpi.com/1660-4601/16/3/452*

Jennings, V., Larson, L., Yun, J., Chakraborty, J., Grineski, S. E., & Collins, T. W. (2016). Advancing Sustainability through Urban Green Space: Cultural Ecosystem Services, Equity, and Social Determinants of Health. *International Journal of Environmental Research and Public Health 2016, Vol. 13, Page 196*, *13*(2), 196. https://doi.org/10.3390/IJERPH13020196

Jiang, B., He, J., Chen, J., Larsen, L., Wang, H. (2021). Perceived green at speed: a simulated driving experiment raises new questions for attention restoration theory and stress reduction theory. *Journals.Sagepub.*, *53*(3), 296–335. https://doi.org/10.1177/0013916520947111

Jürisson, M., Pisarev, H., Uusküla, A., Lang, K., Oona, M., & Kalda, R. (2021). Prevalence of chronic conditions and multimorbidity in Estonia: a population-based cross-sectional study. *BMJ Open*, *11*(10), e049045. https://doi.org/10.1136/BMJOPEN-2021-049045

Kabisch, N., Frantzeskaki, N., Pauleit, S., society, S. N.-E. and, & 2016, undefined. (2016). Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *JSTORN Kabisch, N Frantzeskaki, S Pauleit, S Naumann, MK Davis, M Artmann, D Haase, S KnappEcology and Society, 2016•JSTOR*. https://doi.org/10.5751/ES-08373-210239

Kaczynski, A. T., Potwarka, L. R., & Saelens P, B. E. (2008). Association of park size, distance, and features with physical activity in neighborhood parks. *American Journal of Public Health*, *98*(8), 1451–1456. https://doi.org/10.2105/AJPH.2007.129064

Kajosaari, A., & Pasanen, T. P. (2021). Restorative benefits of everyday green exercise: A spatial approach. *Landscape and Urban Planning*, *206*, 103978. https://doi.org/10.1016/J.LANDURBPLAN.2020.103978

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169–182. https://doi.org/10.1016/0272-4944(95)90001-2

Kondo, M. C., Fluehr, J. M., McKeon, T., & Branas, C. C. (2018). Urban Green Space and Its Impact on Human Health. *International Journal of Environmental Research and Public Health 2018, Vol. 15, Page 445*, *15*(3), 445. https://doi.org/10.3390/IJERPH15030445

Kruize, H., Kamp, I. van., van den Berg, M., van Kempen, E., Wendel-Vos, W., Rujisbroek, A., Swart, W., Maas, J., Gidlow, C., Smith, G., Ellis, N., Hurst, G., Masterson, D., Triguero-Mas, M., Cirach, M., Grazulviciene, R., van den Hazel, P., Niuwenhuijsen, M. (2020). Exploring

mechanisms underlying the relationship between the natural outdoor environment and health and well-being–Results from the PHENOTYPE project. *Elsevier*. https://doi.org/10.1016/j.envint.2019.105173

Liu, Y., Wang, R., Grekousis, G., Liu, Y., Yuan, Y., Li, Z. (2019). Neighbourhood greenness and mental wellbeing in Guangzhou, China: What are the pathways? *Elsevier*. https://doi.org/10.1016/j.landurbplan.2019.103602

Liu, Y., Wang, R., Xiao, Y., Huang, B., Chen, H., & Li, Z. (2019). Exploring the linkage between greenness exposure and depression among Chinese people: Mediating roles of physical activity, stress and social cohesion and moderating role of urbanicity. *Health & Place*, *58*, 102168. https://doi.org/10.1016/J.HEALTHPLACE.2019.102168

Maas, J., van Dillen, S. M. E., Verheij, R. A., & Groenewegen, P. P. (2009). Social contacts as a possible mechanism behind the relation between green space and health. *Health & Place*, *15*(2), 586–595. https://doi.org/10.1016/J.HEALTHPLACE.2008.09.006

Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A. M., de Vries, S., Triguero-Mas, M., Brauer, M., Nieuwenhuijsen, M. J., Lupp, G., Richardson, E. A., Astell-Burt, T., Dimitrova, D., Feng, X., Sadeh, M., Standl, M., Heinrich, J., & Fuertes, E. (2017). Exploring pathways linking greenspace to health: Theoretical and methodological guidance. *Environmental Research*, *158*, 301–317. https://doi.org/10.1016/J.ENVRES.2017.06.028

Mavoa, S., Davern, M., Breed, M., & Hahs, A. (2019). Higher levels of greenness and biodiversity associate with greater subjective wellbeing in adults living in Melbourne, Australia. *Health & Place*, *57*, 321–329. https://doi.org/10.1016/J.HEALTHPLACE.2019.05.006

Mayer, F., Frantz McPherson, C. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology, 2004 Elsevier*, *24*, 503–515. https://doi.org/10.1016/j.jenvp.2004.10.001

McEachan, R. R. C., Yang, T. C., Roberts, H., Pickett, K. E., Arseneau-Powell, D., Gidlow, C. J., Wright, J., & Nieuwenhuijsen, M. (2018). Availability, use of, and satisfaction with green space, and children's mental wellbeing at age 4 years in a multicultural, deprived, urban area: results from the Born in Bradford cohort study. *The Lancet Planetary Health*, *2*(6), e244–e254. https://doi.org/10.1016/S2542-5196(18)30119-0

Nowak, D. J., Hirabayashi, S., Bodine, A., & Greenfield, E. (2014). Tree and forest effects on air quality and human health in the United States. *Environmental Pollution*, *193*, 119–129. https://doi.org/10.1016/J.ENVPOL.2014.05.028

National Statistics Office Malta. (2023). *Census of Population and Housing 2021: Final Report: Population, migration and other social characteristics (Volume 1).* https://nso.gov.mt/themes_publications/census-of-population-and-housing-2021-final-report-population-migration-and-other-social-characteristics-volume-1/

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., Mcdonald, S., … Mckenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. *The BMJ*, *372*. https://doi.org/10.1136/BMJ.N160

Patel, V., Flisher, A., Hetrick, S., McGorry, P. (2007). Mental health of young people: a global public-health challenge. *The Lancet.*

Pettorelli, N., Vik, J. O., Mysterud, A., Gaillard, J. M., Tucker, C. J., & Stenseth, N. C. (2005). Using the satellite-derived NDVI to assess ecological responses to environmental change. *Trends in Ecology and Evolution*, *20*(9), 503–510. https://doi.org/10.1016/j.tree.2005.05.011

Pretty, J., Peacock, J., Sellens, M., & Griffin, M. (2005). The mental and physical health outcomes of green exercise. *Journal of Environmental Health Research*, *15*(5), 319–337. https://doi.org/10.1080/09603120500155963

Qin, B., Zhu, W., Wang, J., Peng, Y. (2021). Understanding the relationship between neighbourhood green space and mental wellbeing: A case study of Beijing, China. https://doi.org/10.1016/j.cities.2020.103039

Reiss F. (2013). Socioeconomic inequalities and mental health problems in children and adolescents: a systematic review. https://doi.org/10.1016/j.socscimed.2013.04.026

Rugel, E. J., Henderson, S. B., Carpiano, R. M., & Brauer, M. (2017). Beyond the Normalized Difference Vegetation Index (NDVI): Developing a Natural Space Index for population-level health research. *Environmental Research*, *159*, 474–483. https://doi.org/10.1016/J.ENVRES.2017.08.033

Tyrväinen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y., & Kagawa, T. (2014). The influence of urban green environments on stress relief measures: A field experiment. *Journal of Environmental Psychology*, *38*, 1–9. https://doi.org/10.1016/J.JENVP.2013.12.005

Wang, R., Helbich, M., Yao, Y., Zhang, J., Liu, P., Yuan, Y., Liu, Y. (2019). Urban greenery and mental wellbeing in adults: Cross-sectional mediation analyses on multiple pathways across different greenery measures. *Elsevier*. https://doi.org/10.1016/j.envres.2019.108535

Weier, J., & Herring, D. (2000). *Measuring Vegetation (NDVI & EVI)*. https://earthobservatory.nasa.gov/features/MeasuringVegetation/measuring_vegetation_2.php?

Whiting, P., Savović, J., Higgins, J. P. T., Caldwell, D. M., Reeves, B. C., Shea, B., Davies, P., Kleijnen, J., & Churchill, R. (2016). ROBIS: A new tool to assess risk of bias in systematic reviews was developed. *Journal of Clinical Epidemiology*, *69*, 225–234. https://doi.org/10.1016/J.JCLINEPI.2015.06.005

Yang, Z., Kwan, M., Liu, D., Huang, J. (2025). How objective and subjective greenspace, combined with air and noise pollution, impacts mental health through the mediation of physical activity. *Elsevier*. https://doi.org/10.1016/j.ufug.2025.128683

Yue, Y., Yang, D., Van Dyck, D. (2022). Urban greenspace and mental health in Chinese older adults: Associations across different greenspace measures and mediating effects of environmental perceptions. *Elsevier*. https://doi.org/10.1016/j.healthplace.2022.102856

Appendices:

Appendix 1: Board of Studies Approval

L-Università ta' Malta

DEPARTMENT OF PUBLIC HEALTH
Faculty of Medicine & Surgery
University of Malta
Msida MSD 2080, Malta

Tel: +356 2340 1117
publichealth.ms@um.edu.mt

www.um.edu.mt/ms

6 February 2025

Subject: Board of Studies acceptance

Student Number: 20496G Email address: gary.d.camilleri.14@um.edu.mt

Dear Dr Camilleri,

This is to confirm that your amended dissertation proposal was accepted by the Board of Studies and you may proceed to apply for FREC approval.

Regards

Prof Neville Calleja
Chair, Board of Studies

Appendix 2: FREC Approval

L-Università ta' Malta

Gary Camilleri <gary.d.camilleri.14@um.edu.mt>

The status of your REDP form (MED-2025-00061) has been updated to Approved

1 message

form.urec@um.edu.mt <form.urec@um.edu.mt> 24 June 2025 at 12:50
To: gary.d.camilleri.14@um.edu.mt

Dear Gary Camilleri,

Please note that the status of your REDP form (MED-2025-00061) has been set to *Approved*.

This status change was accompanied by the following explanation/justification: *Good afternoon, FREC has reviewed your application and has determined that your research in conformity with the University of Malta's research code of practice. You may therefore proceed with your research. Regards FREC*

You can keep track of your applications by visiting: https://www.um.edu.mt/research/ethics/redp-form/frontEnd/.

This email has been automatically generated by URECA. Please do not reply. If you wish to communicate with your F/REC please use the respective email address.*

Appendix 3: Faculty Research Ethics Committee Approval

L-Università ta' Malta

Faculty of
Medicine & Surgery
University of Malta
Msida MSD 2080, Malta

Tel: +356 2340 1879/1891/1167
umms@um.edu.mt

www.um.edu.mt/ms

Ref No: MED-2025-00061

28 July 2025

Mr Gary Camilleri
Ta Romeo
Triq il-Knisja
Ghasri
GSR1101
Gozo

With reference to your application submitted to the Faculty Research Ethics Committee in connection with your research entitled:

Environmental Green Cover and Mental Wellbeing in Malta

The Faculty Research Ethics Committee is granting ethical approval for the above-mentioned application.

Professor Anthony Serracino Inglott
Chair
Faculty Research Ethics Committee

Appendix 4: Approval – Primary Health Care

Primary HealthCare

FRN 1940

Website: http://www.health.gov.mt

PRIMARY HEALTHCARE

7 Harper Lane,
Floriana
FRN 1940

Telephone: + 356 21239993
Telefax: + 356 21222856

1st August 2025

Gary Camilleri
Ta' Romeo. Triq il-Knisja, Ghasri

Re: Your request to carry out a study within the Primary HealthCare Department

Dear Dr Camilleri,

I am pleased to inform you that your request to carry out the research within the department has been **fully approved**.

May I inform you that as we have to abide to the Data Protection Law, **we cannot provide you with a list of data subjects' (clients/patients/staff) personal contact details.** The data subjects also have to sign an informed consent form that also includes a data protection statement (unless it is an anonymous questionnaire) prior to participating (see E below). Any modifications of this approach would have to be first discussed with the data protection officer. Where statistics are involved, only data in terms of age, sex etc can be forwarded to you but not names of individuals.

May I bring to your attention that the researcher is obliged to apply necessary safeguards as a condition for carrying out this research, namely -

A. The personal data (of data subjects) accessed or given are only to be used for that specific purpose to conduct the research and for no other purpose;
B. At the end of the research, all personal data should be destroyed;
C. All references to personal data should be omitted in the report unless an informed consent is specifically obtained from the person being identified in the research report;
D. Participation in the research being conducted should be at the discretion of the individual, and they can refuse any participation whatsoever if they so wish;
E. If data subjects (patients/staff) are going to be interviewed, video recorded or given a non-anonymous questionnaire to fill, an informed consent form should be signed by the participating data subject and a privacy policy statement read to them; Faces should be hidden or digitally modified as to conceal identity;
F. Any other measure deemed fit by the respective Head, depending on the research to be carried out.

I sincerely wish you every success in your studies.

Yours truly,

Dr Glenn Garzia,
Data Protection Officer, Primary HealthCare

Appendix 5: Questionnaire – English Version

Green Cover and Mental Wellbeing Survey

Thank you for participating in this survey. I am Dr Gary Camilleri, currently reading for a Master of Science in Public Health at the University of Malta. This survey is a key part of my course requirements.

The purpose of this survey is to investigate the relationship between environmental greenery and mental wellbeing. Your input is highly valued, as it will contribute to the understanding on how exposure to green spaces impacts psychological health and quality of life.

Before you begin, please read the following consent carefully:

"I understand that my participation in this study is voluntary and that I am free to withdraw at any time without giving any reason and without any adverse consequences. I consent to the processing of the provided data as part of this study. I have been informed that my responses will be kept strictly confidential, will be used solely for the purpose of this research, and will not be shared with any third parties. The results of this study may be published, but my personal information will remain completely anonymous, and no individual participant will be identifiable from the results."

By proceeding to the questionnaire, I acknowledge that I have understood the information provided and agree to participate under these conditions.

Section 1 – Mental Wellbeing, Living Environment, and Social Cohesion

1. **Please respond to each item by marking one box per row, regarding how you felt in the last two weeks.**

	All the time	Most of the time	More than half the time	Less than half the time	Some of the time	At no time
I have felt cheerful in good spirits						
I have felt calm and relaxed						
I have felt active and vigorous						
I woke up feeling fresh and rested						
My daily life has been filled with things that interest me						

2. State whether you have any of the following problems/issues in your current accommodation (Tick one box PER ROW)

	Yes	No
Overcrowding		
Leaking roof, damp floors/walls/foundation, or rot in window frames		
Noise from neighbours or noise from outside E.g. Traffic, business, factories, etc		
Too dark/not enough light		
Pollution, grime or other environmental problems in the area		
Crime, violence or vandalism in the area		
Insufficient ventilation		
Insufficient privacy		

3. How many people in your life are so close to you that you can count on them if you have a serious problem? (Tick one box ONLY)

□ None

□ 1 or 2

□ 3 to 5

□ 6 or more

4. How much concern and positive interest do you feel people show you? (Tick one box ONLY)

□ A lot of concern and interest

□ Some concern and interest

□ Not sure

□ Little concern and interest

□ No concern and interest

5. How easy is it to get practical help from neighbours should you need it? (Tick one box ONLY)

□ Very easy

□ Easy

□ Possible

□ Difficult

□ Very difficult

Section 2 – Social Variables

6. How old are you? (Tick one box ONLY)

□ 18-24

□ 25-34

□ 35-44

□ 45-54

□ 55-64

□ 65-74

□ 75-84

□ 84-94

□ 95+

7. Gender

□ Male

□ Female

□ Other

8. What is the highest level of education that you have successfully completed? (Tick one box ONLY)

□ No formal education/Pre-primary

□ Primary

□ School for persons with a disability

□ Secondary (general)

□ Foundation or Introductory courses at MCAST of one (1) year or less

□ Secondary (vocational) E.g. Trade School

□ Post-secondary (general) E.g. Junior College

□ Post-secondary (vocational) completed before the year 2000 (excluding ITS)

□ Post-secondary (vocational) courses of less than two (2) years E.g. MCAST/MCAST National Diploma, ITS or similar institution

□ Post-secondary (vocational) courses of two (2) years or more E.g. MCAST/MCAST National Diploma, ITS or similar institution

□ University level Diploma/certificate or MCAST Higher National Diploma

□ Bachelor degree or equivalent E.g. University of Malta, MCAST, or other tertiary level institutions

□ Postgraduate Diploma/Certificate

□ Master's Degree

□ Doctorate (PhD/DBA)

□ Other

9. Do you have any longstanding illness or longstanding health problem? (By longstanding I mean illness or health problems which have lasted or are expected to last for six months or more). (Tick one box ONLY) E.g. asthma, diabetes, heart disease

□ Yes

□ No

Section 3 – Physical Activity

Next, I am going to ask you about the time you spend doing different types of physical activity in a typical week.

In this section, when referring to work, keep in mind any sort of paid/unpaid work (e.g. housework, studying or training etc.) is included.

Please answer these questions even if you do not consider yourself to be a physically active person.

10. When you are working, which of the following best describes what you do? (Tick one box ONLY)

□ Mostly sitting or standing

□ Mostly walking or tasks of moderate physical effort

□ Mostly heavy labour or physically demanding work

□ Not performing any working tasks

11. During a typical week, on how many days do you walk for at least 10 minutes continuously to get to and from places? (Tick one box ONLY) For example to work, to school or for shopping.

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ I never carry out such physical activities (Skip to Q 13)

12. How much time do you spend walking in a continuous manner in order to get to and from places on a typical day? (Tick one box ONLY)

□ 10 minutes or more but less than 30 minutes per day

□ 30 minutes or more but less than 1 hour per day

□ 1 hour or more but less than 2 hours per day

□ 2 hours or more, but less than 3 hours per day

□ 3 hours or more per day

13. During a typical week, on how many days do you ride a bicycle for at least 10 minutes continuously to get to and from places? (Tick one box ONLY)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ I never carry out such physical activities (Skip to Q 15)

14. How much time do you spend bicycling in a continuous manner in order to get to and from places on a typical day? (Tick one box ONLY)

□ 10 minutes or more but less than 30 minutes per day

□ 30 minutes or more but less than 1 hour per day

□ 1 hour or more but less than 2 hours per day

□ 2 hours or more, but less than 3 hours per day

□ 3 hours or more per day

15. During a typical week, on how many days do you carry out sports, fitness or recreational (leisure) physical activities that cause at least a small increase in breathing or heart rate, for at least 10 minutes continuously? (Tick one box ONLY)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ I never carry out such physical activities

16. During a typical week, on how many days do you carry out vigorous sports, fitness or recreational (leisure) physical activities that make you breathe much harder than normal for at least 10 minutes continuously? (Tick one box ONLY)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ I never carry out such physical activities

17. In a typical week, on how many days do you carry out physical activities designed to strengthen your muscles such as resistance training, weightlifting, push-ups, sit ups etc? Include all such activities even if you have mentioned them before. (Tick one box ONLY)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ I never carry out such physical activities

18. In a typical week, on how many days do you go for leisure walks (not brisk) for at least 10 minutes continuously for fitness or recreation (leisure)? (Tick one box ONLY)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ I never carry out such physical activities

19. How much time do you spend sitting and reclining on a typical day (exclude time spent sleeping)? (Tick one box ONLY) Indicate in hours.

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ 8

□ 9

□ 10

□ 11

□ 12

□ 13

□ 14

□ 15

□ 16

□ 17

□ 18

□ 19

□ 20

□ 21

□ 22

□ 23

□ 24

Section 4 – Geospatial Information

20. Are you currently employed and/or a student?

□ Yes

□ No (Skip to Q23)

21. Write down the locality where you work or attend school. If you both work and attend school, write the locality where you spend most time from the two.

Locality of work / educational institution: _____

22. Write the street name where you work or attend school. If you both work and attend school, write the street name where you spend most time from the two.

Street name of work / educational institution: _____

23. What is your locality of residence?

Locality of residence: _____

24. What is the street name of your residence?

Street name of residence: _____

---------- END OF SURVEY ----------

Appendix 6: Questionnaire – Maltese Version

<u>Stħarrig dwar il-kopertura ħadra ambjentali u l-benesseri mentali f'Malta</u>

Grazzi talli qed tipparteċipa f'dan l-istħarriġ. Jiena Dr Gary Camilleri, bħalissa qed nistudja għall-Master of Science in Public Health fl-Universita' ta' Malta.

Dan l-istħarrig huwa parti mportanti mir-rekwiżiti ta' dan il-kors. L-għan ta' dan l-istħarriġ huwa li ninvestiga r-relazzjoni bejn l-ambjent ħadrani u l-benesseri mentali. Il-kontribut tiegħek huwa ta' valur kbir, peress li jgħin fil-fehim ta' kif l-esponiment għal spazji ħodor jista' jkollu impatt fuq il-benesseri mentali u l-kwalità tal-ħajja.

Qabel ma tibda l-istħarriġ, jekk jogħġbok aqra bir-reqqa l-kunsens li ġej:

"Nifhem li l-parteċipazzjoni tiegħi f'dan l-istudju hija volontarja u li nista' nirtira fi kwalunkwe ħin mingħajr ma nagħti raġuni u mingħajr konsegwenzi negattivi. Naghti kunsens għall-ipproċessar tad-dejta pprovduta bħala parti minn dan l-istudju. Ġejt infurmat/a li r-risposti tiegħi se jinżammu strettament kunfidenzjali, se jintużaw esklussivament għal din ir-riċerka, u ma jiġux mqassma ma' terzi persuni. Ir-riżultati ta' dan l-istudju jistgħu jiġu ppubblikati, iżda l-informazzjoni personali tiegħi tibqa' kompletament anonima, u l-ebda parteċipant individwali ma jkun identifikabbli mir-riżultati."

Billi nkompli għall-kwestjonarju, niddikjara li fhimt l-informazzjoni pprovduta u naqbel li nipparteċipa taħt dawn il-kundizzjonijiet.

Sezzjoni 1 – Benesseri Mentali, Ambjent ta' Għajxien u Koeżjoni Soċjali

1. Il-ħames mistoqsijiet li ġejjin huma dwar kif ħassejtek f'dawn l-aħħar ġimgħatejn. Għal kull mistoqsija, agħti t-tweġiba li tqarrab l-iktar għal kif kont qed tħossok. F'dawn l-aħħar ħmistax ġieli...?

	Il-ħin kollu	Il-biċċa l-kbira tal-ħin	Iktar minn nofs il-ħin	Inqas minn nofs il-ħin	Kultant	Qatt
Ħassejtek ferħan/a u kuntent/						
Ħassejtek kalm/a u rilassat/a						
Ħassejtek attiv/a u mimli/ja enerġija						
Qomt tħossok frisk u mistrieħ/mistrieħa						

Ħassejt li l-ġranet kienu mimlija b'affarijiet interessanti għalik						

2. Immarka liema minn dawn il-problemi/ċirkustanzi qed tesperjenza fid-dar fejn toqgħod bħalissa: (Immarka kaxxa waħda biss għal kull kategorija)

	Iva	**Le**
Nuqqas ta' spazju/iffullar		
Saqaf inixxi/iqattar, l- art/ ħitan/pedamenti umdużi jew tmermir fiċ-ċaċċis tat-twieqi		
Storbju mingħand ġirien, jew storbju ġej minn barra E.ż. Traffiku, negozju, fabbriki, eċċ		
Dar wisq mudlama/nuqqas ta dawl		
Tniġġis, ġmied, jew problemi ambjentali oħra fl-inħawi		
Kriminalità, vjolenza jew vandaliżmu fl-inħawi		
Nuqqas ta' ventilazzjoni/nuqqas t'arja		
Nuqqas ta' privatezza		

3. Kemm-il persuna f'ħajtek hi qrib tiegħek biżżejjed li tista' tafda fuqha meta jkollok problema personali serja? (Immarka kaxxa waħda biss)

□ Ħadd

□ 1 jew 2

□ 3 sa 5

□ 6 jew iktar

4. Kemm tħoss li n-nies jagħtu kasek u juru interess ġenwin lejk? (Immarka kaxxa waħda biss)

□ Jagħtu ħafna kas u juru ħafna interess

□ Jagħtu kas u juru interess

□ Mhux ċert/a

□ Jagħtu ftit kas u juru ftit interess

□ Ma jagħtux kas u ma juru l-ebda interess

5. Kemm hu faċli għalik biex issib għajnuna prattika mingħand il-ġirien meta ikollok bżonn? (Immarka kaxxa waħda biss)

□ Faċli ħafna

□ Faċli

□ Possibbli

□ Diffiċli

□ Diffiċli ħafna

Sezzjoni 2

6. Kemm għandek żmien

□ 18-24

□ 25-34

□ 35-44

□ 45-54

□ 55-64

□ 65-74

□ 75-84

□ 84-94

□ 95+

7. X'inhu s-sess tiegħek? (Immarka kaxxa waħda biss)

□ Raġel

□ Mara

□ Oħrajn

8. X'inhu l-ogħla livell t'edukazzjoni li temmejt b'suċċess? (Immarka kaxxa waħda biss)

□ M'attendejtx skola/qabel il-primarja

□ Skola primarja

- □ Skola għall-persuni b'diżabilità
- □ Livell sekondarju (ġenerali)
- □ Korsijiet tal-foundation introduttorji fl-MCAST li jdumu sena jew inqas
- □ Livell Sekondarju (vokazzjonali) Eż.Skejjel tas-snajja'
    - □ Livell postsekondarju (ġenerali) Eż. Junior College
    - □ Livell postsekondarju (vokazzjonali) qabel is-sena 2000 (Eskluż l-ITS)
    - □ Livell postsekondarju (vokazzjonali) (korsijiet li jdumu inqas minn sentejn) Eż.MCAST/MCAST Diploma Nazzjonali, ITS jew ekwivalenti
    - □ Livell postsekondarju (vokazzjonali) (korsijiet li jdumu sentejn jew iktar) Eż.MCAST/MCAST Diploma Nazzjonali, ITS jew ekwivalenti
    - □ Diploma/Ċertifikat minn Università jew Higher National Diploma mill-MCAST
    - □ L-ewwel degree/bachelor's degree mill-Università/MCAST jew ekwivalenti. Eż. Università ta' Malta, MCAST jew istituzzjonijiet ta' livell terzjarju
- □ Diploma/Ċertifikat post-graduate
- □ Degree ta' Masters
- □ Dottorat (PhD/DBA)
- □ Other

9. Tbati minn xi mard jew kundizzjonijiet ta' saħħa li ilek tesperjenzahom għal tul ta' żmien? Mard jew kundizzjonijiet ta' saħħa li damu jew huma mistennija li jdumu għal mill-inqas 6 xhur għandhom jiġu kkunsidrati. (Immarka kaxxa waħda biss). Eż.Ażma, dijabete, mard

□ Iva

□ Le

Sezzjoni 3 – Attivita' Fiżika

Issa ħa nistaqsik xi mistoqsijiet dwar kemm tqatta ħin magħtul il-ġimgħa tagħmel tipi differenti t'attivitajiet fiżiċi. • F'din is-sezzjoni, kull tip t'informazzjoni dwar xogħol tirreferi għal xogħol kemm bil-ħlas u kif ukoll bla ħlas (eż. xogħol taddar, studju, taħrig, eċċ). • Jekk jogħġbok wieġeb dawn il-mistoqsijiet anke jekk ma tikkunsidrax lilek innifsek bħala persuna attiva fiżikalment.

10. Meta tkun għaddej/għaddejja bix-xogħol, liema minn dawn li ġejjin jiddiskrivu bl-aħjar mod dak li tagħmel? (Immarka kaxxa waħda biss)

□ Il-maġġoranza tal-ħin bilqiegħda/bilwieqfa

□ Il-maġġoranza tal-ħin timxi jew tagħmel xogħol li jeħtieġ attività fiżika t'intensità moderata

□ Il-maġġoranza tal-ħin tagħmel xogħol fiżiku intensiv ħafna

□ Ma tagħmel l-ebda forma ta' xogħol

11. Issa ħa nistaqsik xi mistoqsijiet dwar kif tivvjaġġa minn post għal ieħor, eżempju biex tmur għax-xogħol, l-iskola, jew għal xi qadja.

Għal mistoqsijiet li ġejjin, tikkunsidrax l-attivitajiet fiżiċi li għandhom x'jaqsmu max-xogħol.

F'ġimgha tipika, f'kemm-il ġurnata timxi għal tal-anqas 10 minuti b'mod kontinwu biex tmur minn post għall-ieħor? (Immarka kaxxa waħda biss)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ Qatt ma nagħmel din it-tip t'attività fiżika (Aqbeż għall-mistoqsija numru 13)

12. F'ġurnata tipika, kemm tqatta' ħin timxi b'mod kontinwu biex tmur minn post għall-ieħor? (Immarka kaxxa waħda biss)

□ 10 minuti jew iktar, imma inqas minn 30 minuta kuljum

□ 30 minuta jew iktar, imma inqas minn siegħa kuljum

□ Siegħa jew iktar, imma inqas minn sagħtejn kuljum

□ Sagħtejn jew iktar, imma inqas minn tliet sigħat kuljum

□ Tliet sigħat jew iktar kuljum

13. F'ġimgħa tipika, f'kemm-il ġurnata ssuq ir-rota għal tal-anqas 10 minuti b'mod kontinwu biex tmur minn post għall-ieħor? (Immarka kaxxa waħda biss)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ Qatt ma nagħmel din it-tip t'attività fiżika (Aqbeż għall-mistoqsija 15)

14. F'ġurnata tipika, kemm tqatta' ħin ssuq ir-rota b'mod kontinwu biex tmur minn post għallieħor? (Immarka kaxxa waħda biss)

□ 10 minuti jew iktar, imma inqas minn 30 minuta kuljum

□ 30 minuta jew iktar, imma inqas minn siegħa kuljum

□ Siegħa jew iktar, imma inqas minn sagħtejn kuljum

□ Sagħtejn jew iktar, imma inqas minn tliet sigħat kuljum

□ Tliet sigħat jew iktar kuljum

15. Issa ħa nistaqsik xi mistoqsijiet rigward attivita fiżika li tagħmel għar-rikreazzjoni tiegħek, sport, jew għal eżerċizzju jew fil-ħin liberu.

Għal mistoqsijiet li ġejjin, attività fiżika li tagħmel waqt li tkun għaddej/għaddejja bix-xogħol u/jew biex tmur minn post għall-ieħor m'għandhiex tiġi nkluża.

Aħseb dwar attivitajiet ta' intensità moderata li jġiegħluk tieħu nifs naqra iktar qawwi missoltu u jistgħu jinkludu; mixi mgħaġġel (brisk walking), ġiri bir-rota b'veloċita normali, jew tennis bid-doppji.

F'ġimgħa tipika, f'kemm-il ġurnata tagħmel xi tip ta' sport jew eżerċizzju fiżiku ta' intensita moderata għal raġunijiet ta' rikreazzjoni (fil-ħin liberu tiegħek), għal tal-anqas 10 minuti b'mod kontinwu, li jwassal biex iżżid bi ftit ir-rata li biha taqta' nifsek u tħabbat qalbek? (Immarka kaxxa waħda biss)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ Qatt ma nagħmel din it-tip t'attività fiżika

16. Għal mistoqsijiet li ġejjin aħseb dwar attivitajiet intensi ħafna, jiġifieri li jirrekjedu sforz fiżiku kbir. Attivitajiet intensi ħafna li iġiegħluk tieħu nifs aktar qawwi (tilheġ) u jistgħu jinkludu aerobics jew ġiri bir-rota b'ċertà veloċità.

F'ġimgħa tipika, f'kemm-il ġurnata tagħmel xi tip ta' sport jew eżerċizzju fiżiku intensiv għal raġunijiet ta' rikreazzjoni (fil-ħin liberu tiegħek), għal tal-anqas 10 minuti b'mod kontinwu, li jwassal biex iżżid b'ħafna rrata li biha taqta' nifsek u tħabbat qalbek? (Immarka kaxxa waħda biss)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ Qatt ma nagħmel din it-tip t'attività fiżika

17. F'ġimgħa tipika, f'kemm-il ġurnata tagħmel xi tip ta' sport jew eżerċizzju fiżiku biex issaħħaħ il-muskoli bħal weight lifting, push-ups, sit-ups, eċċ? Semmi kull tip t'attività simili anki jekk diġà rreferejt għaliha qabel. (Immarka kaxxa waħda biss)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ Qatt ma nagħmel din it-tip t'attività fiżika

18. F'ġimgħa tipika, f'kemm-il ġurnata tmur passiġġata għal tal-anqas 10 minuti b'mod kontinwu għal raġunijiet ta' saħħa jew rikreazzjoni? (Immarka kaxxa waħda biss)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ Qatt ma nagħmel din it-tip t'attività fiżika

19. F'ġurnata tipika, kemm tqatta' ħin bilqiegħda u/jew mimdud/a (eskludi l-ħin waqt li tkun rieqed/rieqda)? (Immarka kaxxa waħda biss)

□ 1

□ 2

□ 3

□ 4

□ 5

□ 6

□ 7

□ 8

□ 9

□ 10

□ 11

□ 12

□ 13

□ 14

□ 15

□ 16

□ 17

□ 18

□ 19

□ 20

□ 21

□ 22

□ 23

□ 24

Sezzjoni 4 – Informazzjoni Ġeospazjali

20. Inti tinsab f'xi forma ta mpjieg u/jew inti student/a?

□ Iva

□ Le (Aqbeż għall-mistoqsija 23)

21. Ikteb il-lokalita' fejn inti taħdem jew tattendi skola. Jekk inti taħdem kif ukoll tattendi skola agħżel il-lokalita' fejn inti l-iktar li tqatta' ħin minn dawn it-tnejn.

Lokalita’ tax-xogħol / istutuzzjoni edukattiva: _____

22. Ikteb l-isem tat-triq fejn inti taħdem jew tattendi skola. Jekk inti taħdem kif ukoll tattendi skola agħżel it-triq fejn inti l-iktar li tqatta' ħin tal-ġurnata minn dawn it-tnejn

Isem tat-triq tal-post tax-xogħol / tal- istutuzzjoni edukattiva: _____

23. X'inhi l-lokalità tar-residenza tiegħek?

Localita’ tar- residenza: _____

24. Ikteb l-isem tat-triq tar-residenza tiegħek

Isem tat-triq tar-residenza: _____

---------- **TMIEM L-ISTĦARRIĠ** ----------

Appendix 7: Information Sheet to Participants (English Version)

Environmental Green cover and Mental Wellbeing in Malta

Information Sheet to Participants

Dear Participant,

You are invited to participate in a study investigating the relationship between environmental green cover and mental wellbeing in Malta. The aim of the study is to understand whether the presence, proximity, and type of environmental greenery impact mental wellbeing.

You have been selected as a potential participant as part of our effort to gather diverse perspectives from the adult Maltese population. Your responses will help us understand how different living environments may influence mental wellbeing.

Your participation involves:

- Completing the attached questionnaire about your mental wellbeing, social environment, and living conditions.
- Providing details of your residential street name and locality to assess environmental green cover around your neighbourhood.
- The questionnaire will take approximately 10-15 minutes to complete.

Participation is entirely voluntary. You are free to decline or withdraw at any time without providing a reason and without any negative consequences. All information will be strictly confidential and will only be used for research purposes.

Your participation will contribute to research that may influence urban planning and mental wellbeing policies in Malta. The collected data will be analysed to explore the association between environmental green cover and mental wellbeing. Findings may be published in academic journals, but no personal identifiers will be included.

If you have any questions, feel free to contact:

Dr Gary Camilleri – gary.d.camilleri.14@um.edu.mt, +35679932302

If you agree to participate, please fill out the attached questionnaire. If you prefer an online version, scan the QR code below

Thank you for your time and participation.

Appendix 8: Information Sheet to Participants (Maltese Version)

Kopertura Ħadra Ambjentali u l-Benesseri Mentali f'Malta

Informazzjoni lill-parteċipant

Għażiż Parteċipant/a,

Int mistieden/mistiedna tipparteċipa fi studju li jinvestiga r-relazzjoni bejn il-kopertura ħadra ambjentali u l-benesseri mentali f'Malta. L-għan tal-istudju huwa li nifhmu jekk il-preżenza, il-prossimità, u t-tip ta' ħdura ambjentali jimpattax il-benesseri mentali.

Int potenzjalment intgħażilt bħala parteċipant/a bħala parti mill-isforz tagħna biex niġbru perspettivi diversi mill-popolazzjoni adulta Maltija. It-tweġiba tiegħek se tgħinna nifhmu kif ambjenti ħodor differenti tal-għajxien jistgħu jinfluwenzaw il-benesseri mentali.

Il-parteċipazzjoni tiegħek tinvolvi:

- Li timla l-kwestjonarju mehmuż dwar il-benesseri mentali, l-ambjent soċjali, u l-kundizzjonijiet tal-għajxien tiegħek.
- Tipprovdi dettalji dwar l-isem tat-triq u l-lokalita' residenzjali tiegħek biex nevalwaw il-kopertura ħadra ambjentali madwar il-viċinitajiet tiegħek.
- Il-kwestjonarju jieħu madwar 10-15-il minuta biex jimtela'.

Il-parteċipazzjoni hija kompletament volontarja. Inti liberu/a li tirrifjuta jew tirtira fi kwalunkwe ħin mingħajr ma tipprovdi raġuni u mingħajr ebda konsegwenzi negattivi. L-informazzjoni kollha se tinżamm kunfidenzjali u se tintuża biss għal skopijiet ta' riċerka.

Il-parteċipazzjoni tiegħek se tikkontribwixxi għal riċerka li tista' tinfluwenza tal-ippjanar urban u l-benesseri mentali f'Malta. Id-dejta miġbura se tiġi analizzata biex tiġi esplorata l-assoċjazzjoni bejn il-kopertura ħadra ambjentali u l-benesseri mentali. Is-sejbiet jistgħu jiġu ppubblikati f'ġurnali akkademiċi, iżda l-ebda identifikaturi personali ma jiġu inklużi.

Jekk għandek xi mistoqsijiet, jekk joġgħbok ikkuntattja lil:

Dr Gary Camilleri – gary.d.camilleri.14@um.edu.mt, +35679932302.

Jekk taqbel li tipparteċipa, jekk jogħġbok imla l-kwestjonarju mehmuż. Jekk tippreferi verżjoni onlajn, skennja l-kodiċi QR hawn taħt.

Grazzi tal-ħin u l-parteċipazzjoni tiegħek.

Appendix 9: List of studies included in the literature review

#	Title	Authors	Year	DOI
1	Does green space matter? Exploring relationships between green space type and health indicators	Akpinar et al	2016	https://doi.org/10.1016/j.ufug.2016.10.013
2	Mental health benefits of neighbourhood green space are stronger among physically active adults in middle-to-older age: evidence from 260,061 Australians	Astell-Burt et al	2013	https://doi.org/10.1016/j.ypmed.2013.08.017
3	Association of urban green space with mental health and general health among adults in Australia	Astell-Burt & Xiaoqi Feng	2019	https://doi.org/10.1001/jamanetworkopen.2019.8209

4	Green space as a buffer between stressful life events and health	Van den Berg et al	2010	https://doi.org/10.1016/j.socscimed.2010.01.002
5	Does time spent on visits to green space mediate the associations between the level of residential greenness and mental health?	Van den Berg et al	2017	https://doi.org/10.1016/j.ufug.2017.04.010
6	Health benefits of green spaces in the living environment: A systematic review of epidemiological studies	Van den Berg et al	2015	https://doi.org/10.1016/j.ufug.2015.07.008
7	The impact of green spaces on mental health in urban settings: A scoping review	Callaghan et al	2021	https://doi.org/10.1080/09638237.2020.1755027

8	Green spaces and general health: roles of mental health status, social support, and physical activity	Dadvand et al	2016	https://doi.org/10.1016/j.envint.2016.02.029
9	Multiple pathways link urban green-and bluespace to mental health in young adults	Dzhambov et al	2018	https://doi.org/10.1016/j.envres.2018.06.004
10	Can biodiverse streetscapes mitigate the effects of noise and air pollution on human wellbeing	Fisher et al	2022	https://doi.org/10.1016/j.envres.2022.113154
11	Do objective and subjective traffic-related pollution, physical activity and nature exposure affect mental wellbeing? Evidence from Shenzhen, China	Huang et al	2023	https://doi.org/10.1016/j.scitotenv.2023.161819
12	Exploring mechanisms underlying the relationship between the natural outdoor environment and health and well-being–Results from the PHENOTYPE	Kruize et al	2020	https://doi.org/10.1016/j.envint.2019.105173

13	Neighbourhood greenness and mental wellbeing in Guangzhou, China: What are the pathways?	Liu et al	2019	https://doi.org/10.1016/j.landurbplan.2019.103602
14	Natural outdoor environment, neighbourhood social cohesion and mental health: Using multilevel structural equation modelling, streetscape and remote-sensing metrics	Liu et al	2020	https://doi.org/10.1016/j.ufug.2019.126576
15	Higher levels of greenness and biodiversity associate with greater subjective wellbeing in adults living in Melbourne, Australia	Mavoa et al	2019	https://doi.org/10.1016/j.healthplace.2019.05.006
16	Urban green space and mental health among people living alone: The mediating roles of relational and collective restoration in an 18-country sample	Pasanen et al	2023	https://doi.org/10.1016/j.envres.2023.116324

17	The relationship between urban greenery, mixed land use and life satisfaction: An examination using remote sensing data and deep learning	S.B et al	2024	https://doi.org/10.1016/j.landurbplan.2024.105174
18	Understanding the relationship between neighbourhood green space and mental wellbeing: A case study of Beijing, China	Qin et al	2021	https://doi.org/10.1016/j.cities.2020.103039
19	Nature's role in supporting health during the covid-19 pandemic: A geospatial and socioecological study	Robinson et al	2021	https://doi.org/10.3390/ijerph18052227
20	Natural outdoor environments and mental and physical health: relationships and mechanisms	Triguero et al	2015	https://doi.org/10.1016/j.envint.2015.01.012
21	Urban greenery and mental wellbeing in adults: Cross-sectional mediation analyses on multiple pathways across different greenery measures	Wang et al	2019	https://doi.org/10.1016/j.envres.2019.108535

22	Association Between Urban Greenspace and Mental Wellbeing During the COVID-19 Pandemic in a U.S. Cohort	Wortzel et al	2021	https://doi.org/10.3389/frsc.2021.686159
23	How objective and subjective greenspace, combined with air and noise pollution, impacts mental health through the mediation of physical activity	Yang et al	2025	https://doi.org/10.1016/j.ufug.2025.128683
24	Urban greenspace and mental health in Chinese older adults: Associations across different greenspace measures and mediating effects of environmental	Yue et al	2022	https://doi.org/10.1016/j.healthplace.2022.102856
25	Associations between urban greenspace and depressive symptoms in Mexico's cities using different greenspace metrics	Bakhtsiyarava et al	2024	https://doi.org/10.1016/j.apgeog.2024.103219